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VOL. 9, No. 2 JUNE, 1943

Some Reflections on the Rural Problem

By

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Nobody will deny that we are now at a cross-roads in Australian agriculture quite apart from the influence of the war, and that a major problem confronts the nation in the reconstruction and reorientation of its agricultural economy. The time might be appropriate, therefore, to emphasise some basic principles which appear to be intimately concerned with the attack to be made on the practical issues.

The problem may be briefly stated as the technical, economic and psychological betterment of agriculture as (*a*) a means of producing food, raw materials and wealth, (*b*) a permanent national asset, and (*c*) a personal occupation for a certain section of the community. In the past the last two objectives have been disregarded almost entirely in the eager, rapid attainment of the first, and this is the root of many disabilities that concern us today. The problem should be attacked primarily by those individuals to whom agriculture offers satisfaction, either directly or indirectly, as a means of existence ; otherwise many essential factors are certain to be neglected. Its solution also presupposes the utmost development and use of scientific and technical resources, co-ordination of research with the educational and advisory services, widespread emphasis on the scientific method, practical awareness and a tightening thread of economics to bind and fortify the numerous factual parts of the general pattern.

Organisation.

Centralisation of directive activity is to be regarded with considerable reservation and distrust. It is obvious that a high degree of co-ordination is needed, and that this should be exercised by the Commonwealth. The problems of agriculture are essentially regional, however, and good machinery is already to be found in the different States, although this is in some cases sadly lacking in respect of adequately trained personnel, considering the magnitude of the task involved.

The present can be regarded as a period of transition, or emergence, and it is not surprising that the urge to greater centralised control has produced a great many Federal bodies associated with agriculture, which appear to be working to an

unfortunate degree at cross purposes. This is likely to be purely a temporary phase.

In the Council for Scientific and Industrial Research and the Standing Committee on Agriculture a framework has been created which makes possible a Commonwealth-wide co-ordination of agricultural research and its application to the material problems of the several States. Whether either body has proceeded sufficiently in the field of co-ordinative activity, or achieved as much as could be in the reduction of overlapping effort, is open to some doubt, but the future may bring improvements in this direction so far as agricultural research is concerned. Research must always be an individual matter and autonomous, but there is scope for harmonisation, interchange of workers and the avoidance of duplication.

If machinery has been provided in the case of research, it certainly has not for education or extension. There is a need in Australia for work by a small but competent body to co-ordinate and stimulate agricultural education and extension based on research and practical experience. The regulation of production is a separate function, and requires to be founded on a knowledge of market requirements and conditions in agriculture throughout the world. There is scope for a single Commonwealth organisation to undertake work of a purely regulatory character, administered presumably on the quota system, but with provision for buffering, including the maintenance of ample reserves. This would necessarily form part of a larger world body, which one hopes will appear after the present conflict.

The Australian Institute of Agricultural Science could perform a national service by stimulating thought, discussion and enquiry concerning the question of Commonwealth agricultural organisation ; it should also do its utmost to ensure that key appointments are filled with the most competent technically-trained personnel available.

Personnel.

Insufficient attention has so far been devoted to the selection, training and effective use of agriculturally-minded young men and women for national agricultural work in Australia. This has been largely a haphazard and fortuitous affair. Granted that many first-class types have emerged from the Agricultural Faculties of the Australian universities, it is still true that there has been little attempt to attract young people of outstanding ability from rural sources and link their university training effectively with the work they will subsequently be called on to perform.

It seems to be generally recognised that there is now sufficient personnel among agricultural graduates in Australia to provide an essential framework of future reconstruction. The lack is in opportunity, in scope and in personal contact, and this lack has become intensified since the outbreak of war, owing to the virtual abandonment of conferences and meetings permitting informal and constructive discussion, and to the pressure of short-term activities.

We need to ask ourselves whether adequate steps have been taken to ensure a sufficiency of properly trained agricultural graduates for post-war work. This is certainly not so in South Australia, where the shortage of technically trained men in the advisory services is really serious. In the absence of a concrete plan for the most effective use of agricultural graduates, either during the war or after it, in important national work, it is not surprising that many have joined the various fighting services and that the number of graduates taking up post-graduate agricultural work has shown a pronounced decline. If we are to plan now for post-war reconstruction, and this presupposes the mobilisation of key personnel throughout the country for open discussion, then we must consider the immediate selection and training of men and women to undertake the many phases of technical activity that require to be followed, not merely " after the war " but with the greatest possible expedition.

Education.

Current systems of education may well prove the root cause of many ills to be found in Australian agriculture today. Much of our education in the wide sense is still based on the detached, narrow, abstract and non-utilitarian format which came into being in the last century. Little has been done to design types of education to serve as practical equipment for those engaged in agricultural production. This is especially true of secondary school education, which still manifests disabilities when viewed as a means of fitting boys and girls for the manifold problems of modern life.

Substantial improvements have accrued in school teaching during the past decade or two, but there is still progress to be made. This can take place only by reorientation and the intensive training of teachers for modern requirements. A child should be taught to observe, to seek interpretation, to think for himself or herself rather than to memorise vast arrays of little-understood facts, for the undisguised purpose of passing examinations or winning certificates.

As cornerstones of education up to and including the Intermediate stage the writer would place English, Mathematics, General Science, and a combination of elementary military training and sport to teach discipline, self-discipline and the unwritten rules of personal ethics. The study of English literature should be designed to reveal the pleasures of reading, to cultivate habits of concentration and exactness and to form the power of elementary critical judgment. Mathematics has, from the time of the Greeks, afforded unique opportunities for the training of the mind in alertness and precision. General Science could be employed widely as a non-vocational course of considerable breadth and versatility, designed to touch one's life and experience at many points, yet emphasising fundamental scientific principles and the scientific method. Clubs, on the basis of the 4-H clubs, could develop very effectively the applied or occupational side of the educational programme.

After fifteen years' association with Intermediate and Leaving Agricultural Science as an examiner, the writer does not hesitate to suggest that the place of this subject in schools could be taken advantageously by General Science if properly integrated and taught in relation to the practical examples afforded by a rural setting, and backed by clubs of the 4-H type. The main limitation to General Science so far has been the pronounced lack of teachers with anything like a general integrated experience. Training has been too narrow, too specialised. The teacher is usually essentially a chemist or a physicist or a biologist ; he rarely possesses sufficient breadth, versatility or practical experience to arouse the necessary interest. It follows that graduates in Agricultural Science should be of value to the teaching of General Science.

Our university courses in Agricultural Science could probably be improved by a greater degree of integration, concentration on principles, elimination of much descriptive matter and a higher degree of vocational training towards the end and immediately following the course. Provided school education has succeeded in establishing fundamentals and has developed in the student a real capacity for independent thinking, a university first year of Physics, Chemistry, Biology, with some Agricultural Geology and some Mathematics, would form a satisfactory foundation, especially if the subjects were linked to examples of practical rural problems. The second year, instead of being purely practical, could well aim at an interweaving of science with practice and afford, in addition, a wide range of practical experience. The third year enables scientific principle to be intensified ; farming experience is obtainable in the vacations. In the fourth year there should be some opportunity for choice, and a limited degree of specialisation is desirable. The graduate is by no means fully trained when he receives his or her degree at the end of the fourth year, and the following year should be regarded as one of apprenticeship.

Work for an Honours Degree, M.Sc. or Ph.D., provides the post-graduate training necessary for research ; similarly in education or advisory work time should be devoted, in this post-graduate period, to vocational training running parallel with the job.

The education of the adult rural community requires to be popular and attractive to be effective. Advisory officers are physically unable to contact more than an exceedingly small percentage of primary producers. The banks, insurance companies, stock and station agents and other commercial agencies are in much closer contact ; the knowledge of these bodies in regard to elementary scientific principles or technical approach is limited, yet there is probably no greater single influence on rural activities than these commercial agencies. If they were enlightened in this regard and their aid enlisted, they could be of much greater service to the farming community. Additional aids are the radio, the press, the cinema, field demonstration. Farm institutes could be developed to serve as meeting places for instruction and discussion. They could be organised in conjunction with the bureau system, which in South Australia has been productive of much good in the past, but is now in need of reorientation for modern requirements. The type of machinery is excellent. The main idea is to encourage the gamut of producers, both young and old, to meet regularly for purposes of popular technical and practical enlightenment. Great numbers meet at show, fair, saleyard and public places at which the opportunity is provided for much educational work.

Our objective in agricultural education should be to develop scientific method and technical understanding in conjunction with practical awareness and experience. A reflective and critical attitude is essential. Work is required to establish principles of outstanding value, to spur the imagination, stimulate thought and provide a strong incentive to consider problems. We need a scientific way of using science by the many rather than an expansion of abstract truth for the few.

Philosophy in Agricultural Science.

One of the main limitations to the progress of Agricultural Science as a vocation is that, so far, it has tended to be a conglomeration of separate subjects, each narrowed in its concept. The agricultural student has for the most part been given snippets from the many sciences that might bear upon agricultural practice ; but the welding of these snippets into an integrated whole, and its emergence as a science-philosophy with an identity of its own is still far from complete.

Anybody who has attempted to pursue the scientific investigation of agricultural problems as they occur in the field must sooner or later be impressed by the sublime artificiality and abstractness of simplified technical lines when compared with the complex, dynamic state of nature. We must accept our biological problems as complex realities to be explored, and the process involves persistent analysis followed by resynthesis. No better example could be quoted than the approach adopted by R. A. Fisher in the Analysis of Variance. Here, the variance is accepted as a whole but partitioned, for purposes of rigorous sub-measurement, into its component parts and their interactions. Synthesis reveals the whole in its dissected and better understood state.

An ecological method of approach, supported by technical knowledge of physiology—not of the test-tube kind—soils and climate, is basic to an understanding of field problems in agriculture. In this regard three principles stressed by John Phillips[5] in his analysis of ecological concepts, are relevant. These are the concepts of emergence, holism, and the complex organism. Emergence or " emergent evolution ", put forward first by Lloyd Morgan,[4] implies the well-known but little appreciated biological fact that an organic whole emerges as something unattainable by mere summation of the parts. It applies cogently to co-operative human

effort. " Holism ", enunciated by Field Marshal Smuts,[7] maintains that the " whole " is to be regarded as a basic concept in biology, conceding the universal tendency towards synthesis in nature, while the " complex organism "[2] stresses the interdependence of individual units in animal, plant or plant *cum* animal communities as part of a complete organisation. The emergence of " personality " in humans has a direct bearing on the first two themes.

As applied to agriculture, an endeavour needs to be made to regard each problem in all its completeness, as well as to study the separated parts, the interrelations of which are frequently all-important. It is not sufficient to consider specialised cropping with wheat or flax, or grazing as an industry, apart from naturally allied factors. This is a basic mistake of the past. We have abundant evidence today of the perniciousness of the wheat-bare-fallow system in the form of weed infestation and soil erosion. Similar problems may follow flax growing. The building of soil fertility through subterranean clover or lucerne, without regard for its utilisation by productive non-legumes, so that aggressive weeds occupy the land, is another case in point. We can cite numerous other well-known examples ; the use of single grasses such as *Paspalum, Phalaris* or rye-grass, leading to failure of the pasture from impoverishment in nitrogen ; improvement of the pasture without regard for the animal ; attention to livestock without consideration of the pasture ; improvement of the crop without assessing its effect on the soil ; study of the soil or the plant as a purely taxonomic unit. There are few agricultural problems in which one of many single factors, some of them quite unsuspected, may not eventually upset the whole to an overwhelming degree.

The concept of the whole goes much further than the boundaries of agriculture. The individual, for ultimate satisfaction, requires, in addition to agricultural efficiency and security, the important objectives of health, domestic happiness, intellectual and moral gratification. He must be satisfied with his niche among his fellow men and the place of his community among others.

Co-operation and Co-ordination.

With the rapid growth in number and in scope of both Federal and State agencies, the necessity for improved co-operation and co-ordination is being increasingly felt. We must be certain that we know what these two terms imply. A helpful discussion of their significance has been given by Ball,[1] who draws the distinction that co-operation is a purely personal effort which must arise from within the individual, whereas co-ordination involves adjustment and harmonisation from without.

Co-operation is essentially an attitude of mind ; most people are reasonable and prepared to co-operate if the advantages are recognized and the principle of " give and take "—not " you give and I take "—is fostered. Stapledon[8] has emphasised the growing need and inevitability of co-operative effort in modern applied research, and has even gone so far as to suggest the submission of joint theses for higher degrees. Ball insists that co-operation presupposes equality of working status and not a relationship of superior and subordinate. On the other hand, it does not require equality of interest or contribution. Perhaps it is not universally desirable, but it can be dispensed with in few cases. It is claimed to improve individual efficiency and stimulate individual effort—a view I heartily endorse. Fostering it in work dependent on public support is an obligation on the administrator. Ball stresses the need for vision, broadmindedness, desire for efficiency, responsibility, fairness, tolerance, unselfishness and friendliness, and also emphasises the need to eradicate fear, selfishness, jealousy, prejudice and unjustness. If these can all be eliminated, obstruction and frustration must automatically disappear. Frequent meetings of staffs are essential, and one must learn that sacrifices on the part of the individual

for the benefit of the group are likely to result in benefit to the individual also. Ignorance, excessive institutional pride and professional jealousy are among the major enemies of co-operative effort.

Co-ordination means formal and accepted adjustment arising out of enlightened leadership. Special organisations or appointments may be required to promote co-ordination, and the degree of vision, unselfishness and versatility displayed by the personnel involved will determine in large measure the amount of success achieved.

Planning.

It is important to realize that we need to plan specifically for our own particular conditions, and should avoid following slavishly the methods employed in, say, Great Britain or the United States without due regard to their local applicability. Our problems in themselves are unique.

Since planning involves co-ordination, it is affected by the influence of personnel and personalities. The subject matter is usually eclectic, yet diffuse and complex in its linkages. There is often little foundation of factual matter or knowledge of effective procedure. A primary need is the formulation of clear statements of objectives, followed by careful adherence to any agreements made, except by tacit revised agreement.

A major difficulty in the co-ordination of separate bodies or organisations is that each may hesitate to act unless it can be the co-ordinator. This tends to put out of court all established official bodies as effective co-ordinators, and to suggest that special independent co-ordinating machinery may be necessary. It might well be that accepted leaders among the rural people themselves could play a prominent part in co-ordinative activity, and that technical organisations are more properly concerned in the leadership of ideas. The creation of a strong Federal rural organisation by synthesis from simple local autonomous bodies of primary producers could go far towards ensuring effective planning, if emphasis were placed on the promotion of adult and juvenile education along the lines previously indicated, and on seeking guidance from all available technical sources. This can better be done on a basis of natural regions and sub-regions, with much emphasis on local autonomy, than in terms of States. There is a great deal to be said for community planning and co-operative farming, but both will always be limited by the capacity of the individual, which goes back to education, and possibly also to nutrition. The crux of the problem is the maintenance and intensification of further scientific enquiry, closely linked with agencies for effective education and extension.

The maintenance of both fundamental and applied research is indispensable to general progress, because discoveries that are liable to revolutionise both approach and method are always liable to be " just around the corner ", and knowledge of our own country, its conditions and possibilities, is still barely past the exploratory stage. In the field of soil deficiencies, in their relation to plant and animal health and our own resistance to infection, a tremendous amount has still to be learnt under Australian conditions.

I am unable to agree with the recent suggestion that research is essentially the prerogative of youth.[6] There are too many examples in the world of outstanding contribution from men of fifty and over to justify this view. I would rather put it that some minds develop early and, following a decade or more of intensive creative effort, become content to rest, in a creative sense, on their laurels ; or else the genius may die. Other intellects develop slowly, building a foundation for fruitful effort in later life. Frustration of the younger men, so evident in recent years, has been in many cases due, in my view, to a failure on the part of some leaders to appreciate the rapidly changing outlook of youth and the need for really

stimulating leadership that takes into account the urge arising in able men to find intellectual adventure in keeping with the times. The natural researcher is something of a scout ; he requires stimulus and assistance in the development of his ideas rather than direction or excessive routine duty. In applied work such as agricultural research, it is difficult for the younger men to continue patiently with their researches when the extension services, for various reasons, patently fail to apply to practice the results of much persevering effort.

Major Problems.

The following are some of the major problems of agricultural reconstruction in southern Australia.

1. Restoration of existing agricultural areas, embracing :
   (*a*) Diversification ; development of new crops.
   (*b*) Increased combination of livestock with cropping ; pasture improvement.
   (*c*) Greater production of home-grown foods of good nutritive value.
   (*d*) Control of soil erosion.
   (*e*) Control of noxious weeds.
   (*f*) Afforestation on farms ; shelter belts.
2. Regeneration in pastoral and marginal areas ; management of pastures ; regeneration of tree cover.
3. Development of scrub-lands in areas of high and assured rainfall ; solution of mineral deficiency problems.
4. The intensive development of irrigable land and the maximum use of available irrigation supplies.
5. Avoidance of waste by the more efficient treatment and processing of agricultural products, and the greater use of farm by-products.
6. The application of economic principles to the factual details associated with these problems.
7. The improvement of living conditions in rural areas.
8. The advancement of agricultural education and extension and their closer linkage with research.
9. The regulation, within limits, of production, of costs and of prices.

In each of these there is a multitude of technical problems still to be solved, and, on solution, the results need to be applied effectively in practice.

The steps to be taken in the attack on each problem are those listed by Donald[3] as being necessary for efficient land use, namely : (1) survey, (2) research, (3) planning, (4) realisation by (*a*) education and publicity, (*b*) demonstration, (*c*) local community endeavours, (*d*) legislation. The mistakes of the past and the present should by this time have made it quite clear that it is futile to plan or to pursue development unless survey and research have proceeded to a sufficiently informative degree. Survey and research, on the other hand, can be fully effective only when linked, one with the other, and each with sympathetic and enlightened extension work.

References.

1. Ball, C. R. : Lecture to Extension Workers, Manhattan, Kansas, 1939.
2. Clements, F. E. : Year Book, Carnegie Institute, 16-32, 1917-33.
3. Donald, C. M. : J. Aust. Inst. Agric. Sci., 7 : 96-104, 1941.
4. Morgan, L. : Gifford Lectures, Williams and Norgate, London, 1929.
5. Phillips, J. : J. Ecol., 23 : 488-508, 1935.
6. Prescott, J. A. : Aust. J. Sci., 5 : 93-95, 1942.
7. Smuts, J. C. : Holism and Evolution, Macmillan, London, 1926.
8. Stapledon, R. G. : Science Progress, 32 : 453-462, 1938.

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The Structure of Pig-Production Costs

By

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The Australian pig industry has grown up as a sideline to the dairying industry ; the pig has been a convenient " drain " for skim milk, the chief by-product of cream production, which is perishable, largely unsaleable, and forms an offensive effluent if allowed to run into an ordinary drain or stream. Further, this biological " drain-pipe " has given some return though, at times, it may have been very small.

Until the development of an appreciable export trade in pig meats during the past decade the industry suffered from frequent alternations of glut and scarcity. So long as the Australian market formed the only outlet for pig meats, the industry appeared likely to remain a sideline.

The development of export brought more stability to the industry and gave promise of an expansion beyond the sideline phase. In the years immediately before the war, pig production, as an independent industry, was being developed by a few individual farmers. Such piggeries depended for their food supply on home-grown or purchased grain with meat meal instead of milk as the source of protein. Some of these pig raisers were grain growers seeking a better return for their grain through pigs than they could obtain for it as a cash crop.

The war and especially the presence of American troops in this country has greatly increased the demand for pig meats. The recently introduced pig-meat plan, which is intended to stimulate the production of the required supply, is another event which affects the development of the industry. The present, therefore, is an appropriate time to review the costs and economic principles in the two main types of pig production.

Economics of Pig Production as a Sideline.

Most sidelines, especially " compulsory " sidelines among which pig production on dairy farms may be classified, present particular difficulties in costing. Sometimes a sideline results in more efficient use of the farm labour ; the time saved, if the sideline were discontinued, might not be otherwise gainfully used. In a rigorous system of costing all the labour expended on a sideline is charged against the product. Rigidly enforced, such a system may prove that a particular sideline is unprofitable in spite of the fact that the farmer would be worse off if he were to discontinue it. This would have been the case on many occasions in the pig industry.

To attempt to define what constitutes a profitable price for the sideline pig-raiser, therefore, is unreal. As long as he can buy or raise store pigs more cheaply than he sells them as fats and so long as his operations are on such a small scale that the labour of feeding and caring for his few pigs does not lead to neglect of his other farm work, he generally derives some actual profit from keeping pigs.

The more realistic approach to the economics of sideline pig production, therefore, is that commonly adopted by farmers themselves, who speak of the net return per gallon of milk. This figure represents the difference between the out-of-pocket expenses on the pigs and the net sale price divided by the gallonage of skim milk. For many years the accepted normal return was one penny per gallon. Broadly speaking, pig prices that showed a higher return per gallon tended to encourage production ; lower prices tended to bring about a contraction.

Potential Pig-producing Capacity of Dairy Industry.

The potential pig-producing capacity of the dairying industry is substantial. McMeekan[4] estimates that, after making allowance for the maintenance of breeding stock, about 42 lb. of pig meat can be produced from the skim milk remaining from 100 lb. of butter fat, 48 lb. from the buttermilk from one ton of butter and 21 lb. from the whey from milk containing 100 lb. of butter fat. If the total quantities of these by-products were fed to pigs without any supplement, about 70,000 tons of pig meats could be produced annually in Australia. But, though milk by-products produce good quality pork and bacon, the feeding of them alone is nutritionally wasteful. Milk and buttermilk are over-rich in protein. If these by-products were fully balanced with grain and the full production of both were available for pig production, the potential pig-producing capacity of the Australian dairying industry would be about half a million tons of dressed pork or bacon a year.

Even this great quantity, however, does not represent the full capacity of the dairying industry. The calculation ignores an important practical point, namely, that the full utilisation of the dairy by-products would entail a level of stocking during the flush period of dairy production which could not be maintained throughout the whole year. In that event meat meal and, still more, grain, would have to be fed during the periods of milk scarcity. This would again increase the potential output.

Economic Problems in Sideline Production.

In pre-export days the major economic problems of pig raising as a sideline to dairying were (1) whether it paid better to breed or to buy the pigs required to use up the available skim milk supplies ; (2) whether the returns per gallon of milk could be improved by supplementing the milk with grain ; (3) what grain was the most profitable supplement ; (4) whether greater returns per gallon could be obtained by raising one or two litters per year. The answers to these questions depend largely upon the individual dairy farmer's circumstances. It appears that the man who breeds his own pigs obtains a better return per gallon than the man who purchases store pigs ; the farmer who buys invariably pays high prices for " stores ". When he needs pigs, other farmers are also on the market for them.

In pre-export days at least, grain feeding was not regularly profitable. Though advisable on nutritional grounds, and though it enables a greater number of pigs to be fattened, the purchase of grain sometimes lowers the net return per gallon of skim milk. Home-grown grain is sometimes a cheaper source of supplement but such grain may at times have a higher alternative return as a cash crop.

The chief factor deciding whether grain should be used is the feed-price ratio, that is, the ratio of cost of grain to the price of pork or bacon. No direct work has been done in Australia to establish the profitable threshold ratio.

The choice of the most profitable grain is a matter which involves cost per bushel and nutritive value. Experimental work on pig feeding in Australia to date has largely centred around this point.

The supply of skim milk is not constant throughout the year. According to Scott[5] the monthly requirements of a sow and her two litters raised to bacon weight, expressed as a percentage of the total year's requirements, are : first month, 3·7 per cent. ; second, 7·2 ; third, 9·0 ; fourth, 9·5 ; fifth, 12·5 ; sixth, 8·1 ; seventh, 3·7 ; eighth, 7·2 ; ninth, 9·0 ; tenth, 9·5 ; eleventh, 12·5 ; twelfth, 8·1.

This variation in requirement does not coincide with the normal lactation curve of a reasonably well-fed dairy herd. The requirements of the piggery, however, can be adjusted by selling excess pigs as weaners or porkers. The requirements can also be varied by staggering the farrowings. These methods, however, are not completely successful. The staggering of farrowings is more practicable in a large

piggery than in a small one. The sale of young pigs from autumn litters is apparently so unprofitable that many dairy-farmers-pig-raisers breed only one litter a year from their sows. New Zealand statistics, quoted by McMeekan[4] show that 80 per cent. of the brood sows in that country produce only one litter a year. These figures are probably not equally applicable to Australia, but the similarity between the position of pigs on New Zealand dairy farms and those on Australian dairy farms is fairly close. New Zealand figures are at least indicative of an economic trend. A great deal of work has been done in New Zealand, mainly by Scott, to evolve economical means to carrying autumn litters through the winter.

Dairying as a Basis for Expansion.

The dairy-farmer-pig-raiser represents the hard core of the pig industry. He keeps the industry alive even when pig prices show a slender return. His system of production is elastic. When returns are low, he can contract the scale of his operations to the minimum necessary to cope with the skim milk. When returns are high, he has what is probably the most economic basis for expansion in his skim milk supply. Milk has a high biological value. Rations containing it almost invariably give higher growth rates than those without milk even when the latter are correctly balanced.

So far as the war-time pig-meat plan concerns the dairy-farmer-pig-raiser it is to be judged by (1) whether it gives him an adequate net return per gallon ; (2) whether the feed-price ratio is sufficiently favourable to encourage him to use grain and thereby increase his output.

Pig Raising as an Independent Industry.

Pig raising as an independent enterprise lends itself more readily to direct costing. No statistics are available to indicate the relative importance of this type of pig production, but the indications are that the total production from this source is relatively small in comparison with that from the dairying industry. It is from this type of pig production, however, that the greater proportionate increase in output is expected. There are certain practical difficulties to expansion in the dairying industry, namely the difficulty of landing grain on the farms at reasonable cost, the reluctance of many dairy farmers to expand their pig raising beyond the sideline stage, the higher rainfall of dairying areas with its attendant mud, and in these days, of course, manpower.

There are numerous arguments in favour of a pig industry in the grain-producing areas. First of all, pigs do not use fibrous feeds satisfactorily. Any large-scale development of pig raising depends upon the greater use of grain. The logical place to use the grain for pig feeding is in the district where it is grown, and better still, from the fertility point of view, on the farm where it is grown. It takes about 4 lb. grain to produce 1 lb. of pork. In days of restricted transport it seems better to carry the finished product around the country than four times its weight in grain. Further, it has always been regarded as good farming policy to market a part of a crop as livestock rather than entirely for cash.

Two main types of independent pig-raising exist : (1) those which depend upon purchased grain ; (2) those which depend upon home-grown grain.

The first is obviously more vulnerable than the second, i.e. its success depends upon a continuously favourable feed-price ratio. From a long-term point of view the second is in a similar position. Its only long-term advantage is the saving on the cost of cartage and commission on the grain. It can, however, better weather a period with an unfavourable feed-price ratio, accepting the lower return for grain than the net cash price in the expectation that over a period of years the pigs will give a better profit than cash cropping.

Sources of Information.

The estimated costs of production of the independent system of pig raising are set out in Tables 1 and 2. Costs have been divided into the following six classes: feed, labour, sow depreciation, service costs, housing, commission and yardage, together with a group of miscellaneous charges.

The figures for feed consumption shown in Table 3 were based upon a table prepared by M. J. Scott, B.A., B.Sc., former Lecturer in Animal Nutrition, Canterbury Agricultural College, and now Superintendent of the Pig Industry, New Zealand Department of Agriculture. There may be criticism of the feed allowances per

TABLE 1.

Costs of Production of Baconer Pigs.

Unit consists of 30 sows and one boar; employing one man; sows average 14 pigs per year (two litters of seven).

	Cost per sow and 14 baconers for the year.	Cost per 140 lb. baconer.	Cost per lb. bacon.
	£ s. d.	£ s. d.	d.
Feed. To keep sow during the year and to raise her progeny to bacon weights: 5 tons at £7 per long ton	35 0 0	2 10 0	4·28
Labour. One man at £5 per week	8 13 4	0 12 5	1·06
Sow Depreciation. Sow costs £6 6s. at 3 to 4 months. Feed to bring her up to breeding age makes her total cost at first mating about £9. Breeding "life", 6 litters. Value as backfatter in normal times about £5, i.e. depreciation £4 over 3 years	1 6 8	0 1 11	0·16
Boar Costs. Boar depreciates at the rate of £2 a year from his total cost at first mating. He costs £5 a year to feed with feed at £7 a long ton. Annual cost: £7, divided among 30 sows	0 4 8	0 0 4	0·03
Housing Depreciation. 1s. 6d. per pig per year (Downey[2])	1 1 0	0 1 6	0·13
Commission and Yardage	4 1 4	0 5 9	0·49
Miscellaneous Costs. Based upon the complete records of a large commercial piggery	4 0 0	0 5 8	0·49
Total	54 7 0	3 17 7	6·64

TABLE 2.

Costs of Production of Porker Pigs.

Unit of 40 sows and two boars; employing one man; sows average 14 pigs per year.

	Cost per sow and 14 porkers for a year.	Cost per 90 lb. porker.	Cost per lb. pork.
	£ s. d.	£ s. d.	d.
Feed. For sow and her 14 pigs to porker weight. 3·4 tons at £7 a ton	23 16 0	1 14 0	4·53
Labour. One man at £5 per week	6 10 0	0 9 4	1·24
Sow Depreciation.—As given in Table 1	1 6 8	0 1 11	0·16
Boar Costs	0 7 0	0 0 6	0·05
Housing Depreciation. As given in Table 1	1 1 0	0 1 6	0·20
Commission and Yardage	2 15 5	0 3 11	0·53
Miscellaneous Costs. As given in Table 1	4 0 0	0 5 8	0·76
Total	39 16 1	2 16 10	7·47

pound gain at various stages of growth, but the totals show almost exact coincidence with the detailed records of a commercial piggery in which Scott conducted numerous feeding trials.

TABLE 3.
Feed Required per Year for a Sow plus Two Litters of Seven Pigs Each.

Sow maintenance	2,160 lb. of a mixture composed of 10 per cent. meat meal and 90 per cent. grain.
Feed for litters to weaning (40 lb. live weight)	800 lb., i.e. 57 lb. per head.
Feed for litters from weaning to porker weight (130 lb. live weight).	4,680 lb., i.e. 334 lb. per head or 3·71 lb. per lb. gain.
Feed for litters from porker to bacon weight (200 lb. live weight).	3,540 lb., i.e. 253 lb. per head or 3·62 lb. per lb. gain.

The estimated costs show no direct allowances for losses. The allowance is an indirect one, a certain output per sow per annum having been taken as the basis of assessment. Such a system assumes that most of the losses occur in early life—which is so, and that the feed consumed by each pig which dies will not largely affect the total for the sow and her two litters per annum. This is partly true ; a further safeguard is provided by the higher allowances per pound gain to the pigs up to porker weight ; actually, a porker uses less feed per pound gain than a baconer. The miscellaneous charges also form a minor reserve against under-estimation.

An output of 14 pigs per sow is probably higher than the normal in a large piggery, although it is often exceeded in small piggeries in which the owner attends to the pigs himself. Under large-scale conditions in New South Wales, where the Tamworth-Berkshire cross is common, 10 pigs per sow per annum seems to be more typical. In one large piggery with exact records the sales from 150 sows last year amounted to 1,500 pigs—an average of 10 per sow. In Victoria, where Large Whites are more common, Downey[2] considers an average of 14 is typical.

The costs listed as miscellaneous are more variable, perhaps, than the others. They are intended to include the innumerable, inevitable, small charges that make the difference between the expected and actual returns from pig raising. The amount of £4 per sow was arrived at in consultation with a large-scale pig raiser, who keeps 130 to 140 sows and who has detailed records extending over several years. These miscellaneous items include rates, water supply, cartage, electricity, insurance, tools and repairs, telephone, harness repairs, and veterinary fees. Several of these items are appreciable. It is surprising, for example, how many brooms are worn out in a large piggery each year. The maintenance of a horse and cart can also be a substantial item if no horse feed be grown on the farm. While the total amount of miscellaneous charges may seem high, it works out at only ½*d.* per lb. bacon. The selling charges on pigs are high ; they amount to nearly as much as the miscellaneous. Commission alone is 5 per cent., equivalent to 0·4*d.* per lb. bacon when bacon is 8*d.* per lb. Yard dues, yarding and drafting, vary from market to market ; in Sydney they amount to 9*d.* a head.

Only direct costs have been included. If these costs were to be used to determine the price required for profitable operation, it would be necessary to add interest on capital invested in the enterprise.

TABLE 4.
Costs with Smaller Litters.

Average number of pigs per sow annually.	Cost per lb. pork.	Cost per lb. bacon.
	d.	*d.*
12	7·95	7·10
10	8·44	8·10

Table 4 sets out the estimated costs of production of pork and bacon with smaller litters. These figures have been calculated by keeping constant all the costs per sow-unit and varying the quantity of feed according to the number of pigs reared. This method introduces minor inaccuracies but gives a fair picture of the effect upon costs of production per pound.

Significance of the Costs.

The figures in Tables 1 and 2 emphasise the dominant influences of feed and labour costs. The feed cost of £7 a long ton is equivalent to wheat at 3*s*. 5*d*. a bushel and meat meal at £10 a short ton, the mixture comprising 10 per cent. of meat meal and 90 per cent. of grain.

Feed at £7 a long ton makes the feed cost 4·28*d*. per lb. of bacon with a 14-pig output per sow ; a change of £1 a ton, therefore, swings the cost of production by 0·61*d*. per lb. bacon.

Textbooks often stress the high cost of protein. Protein is costly per pound when compared with carbohydrate, but the proportion of protein-rich feed used in the mixture is only one-ninth of the carbohydrate-rich. The feed mixture stated above costs 6*s*. 3*d*. per 100 lb. Of this amount, the grain costs 5*s*. 1½*d*. and the meat meal 1*s*. 1½*d*. If the price of grain changes by £1 a long ton, it swings the cost per 100 lb. of the mixture by about 9*d*. If the price of meat meal changes by £1 a long ton it swings the cost of the mixture per 100 lb. by about 1*d*. Cheap grain is the main factor in profitable pig production. Meat meal is in short supply in some districts. It is more important to be able to obtain meat meal than to be able to buy it cheaply.

The sharp rise in production costs with decreasing output per sow, indicated in Table 4, emphasises the importance of high litter numbers and a high survival rate. Breed, strain, management and disease are the factors that affect the output per sow.

The difference between porker and baconer costs—nearly 1*d*. per lb. dressed meat—brings out an economic principle of importance in pig raising. The fact that bacon costs less per pound than porker is not peculiar to the above figures. It is true even when the feed consumption per pound gain of the baconer is greater than the feed consumption up to the porker stage.

Pork costs more than bacon because the overhead costs such as sow maintenance are spread over a lesser quantity of pig meat. Most of the overhead in pig raising is incurred during early life. It tapers off as the pig approaches maturity, that is, the curve of production-cost *per lb*. falls as the pig grows. This falling cost line exhibited by the fattening pig makes it possible for a pig to cost more per pound live weight as a weaner than it brings as a baconer and still be profitable.

There is an interesting comparison to be made between the stall-feeding of cattle and the fattening of pigs. As a pig approaches bacon weight, the cost of feed, at present feed and bacon prices, is between one-third and one-half of the value of each pound of gain. This is due to the high efficiency of the pig as a converter and the high ratio of dressed to live weight. In the stall-feeding of cattle the cost of each pound gain is just about equal to its value. Under such conditions the profit lies in being able to purchase the store cattle at a lower price per pound than they bring as fats. Cattle, therefore, exhibit a rising cost-curve.

Perhaps the chief significance of these figures is to suggest that the production of pigs as an independent industry will require a stable market of more than 7*d*. per lb. for bacon—that is, if pigs are to return the equivalent of 3*s*. 5*d*. for wheat and maize and 2*s*. 10½*d*. for barley. These grain returns are not regarded as highly profitable ; yet more than 7*d*. per lb. for bacon is above the pre-war normal figure. The basic reason why pig raising, based on grain, seems unlikely to develop into a large industry in Australia lies in the absence of a large feed-grain industry, and that traces back to the variability of the Australian rainfall, which requires us to hand feed our sheep and cattle only at irregular intervals.

The chief hope of a grain-based pig industry is in the greater development of grain that can be produced and sold at a low figure. Barley seems to be the most promising grain for the south and grain sorghum for the areas with a summer rainfall. Sorghum holds out more promise for the northern areas than maize. It is more drought-resistant. The area suitable for sorghum is much more extensive. The crop lends itself to complete mechanisation, an important step towards low production costs.

Some of the above costs could be reduced. For instance, in a large piggery it is possible to handle more than 30 sows per man. On the other hand, a high level of management efficiency is necessary in a large establishment. Experience in England and here[3] indicates that it is difficult to maintain a large pig-breeding establishment ; disease eventually creeps in with disastrous consequences. Most of the large-scale piggeries that persist do so in the end as fattening propositions only. The breeding tends to become concentrated in the hands of the smaller men.

Another sphere for economy is in the feeding of the sows. The feeding scale in Table 3 provides for the sow obtaining very little other than minerals and accessory food factors from pasture. For eight months of the year—that is, during the two gestation periods—savings of up to 3 lb. meal a day could be effected by giving the sows good quality grazing. Normally, grazed feeds cost about one-fifth as much per lb. starch equivalent as grain. A saving of 3 lb. a day for eight months, after deducting the cost of grazing, is an economy of £1 16*s.* 0*d.* per sow-unit, 2*s.* 7*d.* a baconer, or 0·22*d.* per lb. bacon. The full effects of such economies are difficult to assess. Some recent New Zealand work indicates that a low plane of nutrition for a few weeks after mating may reduce litter numbers. The real economy, therefore, may be slight.

Varying Returns from Grain and Milk.

The economic picture of pig production is not complete without mention of the varying returns obtained from milk and grain at different levels of feeding. Barratt and Mercer[1] showed that milk fed at the rate of only half a pint per pig per day as an addition to a balanced ration of grain and fish meal gave a return of 5*d.* to 7*d.* per gallon. Such a return is much higher than could be accounted for by the quantity of protein or energy provided by this quantity of milk. It is probably due to the biological value of the milk proteins or vitamins. An equally high return was recorded in a student's pig-feeding project at the McGarvie Smith Farm. As the quantity of milk is increased, the return drops sharply to the level represented by its energy and protein contents. The shape of the curve of returns from milk is an important economic problem to the pig raiser whose feeding is based on grain ; it might pay him to keep a few cows to provide a minute quantity of milk all around.

A similar problem occurs when the feeding is based upon skim milk. McMeekan[4] states that even small amounts of grain greatly increase the returns from the milk. Very likely, as Downey[2] suggests, the curve of returns from grain added to skim milk shows a similar curve at the lower end of the scale to that of milk. Both problems, however, require further investigation ; in fact, they have such a large potential effect upon economics of pig production that they could well be given a high priority in any future pig feeding trials in this country.

References.

1. Barratt, S., and Mercer, W. B. : Pig Breeders' Annual, 15 : 31-36, 1935-36.
2. Downey, L. : Private communication.
3. Hammond, J. : Press interview with author, Melbourne, 1938.
4. McMeekan, C. P. : Agricultural Organisation in New Zealand. N.Z. Instit. Pacific Relations. Melbourne Univ. Press, 1936.
5. Scott, M. J. : Private communication.

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Diseases of Native Plants in Queensland*

By

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On December 6, 1801, Matthew Flinders anchored the *Investigator* in King George's Sound. His task was to complete the survey of the coast of Australia. With him was the great botanist Robert Brown, whose botanical collections on that historic voyage and during the three subsequent years that he spent in Australia exceeded those made on all previous voyages. Brown[3] made the first recorded list of Australian fungi—*Rhizomorpha setiformis, Tubercularia vulgaris, Sphaeria ophioglossoides, Clavaria pistillaris, C. coralloides, Peziza scutellata, Boletus igniarius, Agaricus alneus, A. muscarius* and *A. campestris.* His interests were obviously not mycological, but the list was a starting point.

From the years 1839 to 1886, Berkeley in England was publishing a steady stream of contributions to the fungal flora of Australia, often under great difficulties because of the imperfect material sent to him. M. C. Cooke's papers started to appear in 1870, and those of George Massee followed, the first in 1887. Reference to these works is cited by McAlpine.[18] The work of these pioneer writers was made possible by the collections of such men as Sir Joseph Hooker, Baron von Mueller and F. M. Bailey. To Bailey we are specially indebted for making possible the great contributions to the knowledge of Queensland mycology during his tenure of the office of Colonial Botanist. In 1892, Cooke's *Handbook of the Australian Fungi*[8] was published. It had many defects. Many of the determinations were based on very scanty material, often in a poor state of preservation, and it is often impossible to identify species from the descriptions. This is largely due to inadequate material described by a man in a distant country, but does not alter the important fact that it was the first attempt to put some coherence into the great mass of data accumulated during the nineteenth century.

The task of correcting its inaccuracies and filling out the gaps must devolve on local workers with a first-hand knowledge. Fortunately in 1890 the late Daniel McAlpine was appointed as Plant Pathologist to the Victorian Department of Agriculture. His first major work was the compilation and publication of a list of Australian fungi,[18] with an appended host index of the parasitic species. This appeared in 1895, and increased the list by nearly three hundred, Cooke's total in 1892 being just over two thousand. McAlpine's later work was concerned mainly with pathogenic fungi, and the increases in numbers resulting from a systematic local study are demonstrated by the rusts and the smuts. Cooke listed 72 rusts and 27 smuts. McAlpine's investigations more than doubled the number in both groups ; in 1906 he recorded 160 rusts,[19] and in 1910, 68 smuts.[20]

There is no need to give a detailed account of the progress of mycological knowledge in Australia beyond mentioning that although other Australian workers have been continually adding to the list and correcting earlier mistakes, and overseas authorities have made important contributions, the mycological field is still far from completely explored. Medical mycology is a pale shadow of what it might be. We have a wealth of Agaricaceae and other groups which in other countries possess species highly prized as food, but our experience is largely confined to a few species

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of mushroom. We know comparatively little of the poisonous species, as witness the cases of poisoning of a number of people on the north coast of New South Wales in January, 1941, by *Panaeolus ovatus*, the hysteria fungus. *Lepiota dolichaula* is suspected of poisoning cattle in New South Wales, but in Queensland it is thought harmless.

The Ergot Situation.

The question of the poisonous nature of certain fungi is an important aspect of the study of the diseases of native plants. Various members of the grass family are affected by ergot, the best known example being ergot of rye, caused by *Claviceps purpurea*. Since the end of the eighteenth century it has been used in obstetrics, and though the greater part of the commercial material has been obtained from naturally occurring sclerotia in diseased rye, considerable progress has been made within recent years in artificial inoculation of the host, especially in Russia. The best product comes from Poland and Spain, and owing to shortage of supplies due to war conditions, attempts have been made, at the request of the British Pharmaceutical Society, to raise supplies in Australia.

Claviceps purpurea was no newcomer to Australia. It had been listed in McAlpine's census[18] of 1895. Ergotism had been recorded from the New England district in New South Wales, and Noble *et al.* [25] in 1935 recorded *C. purpurea* from *Bothriochloa intermedia, Bromus inermis, Dactylis glomerata, Festuca* spp., *Lolium* spp., *Panicum bulbosum, Phalaris minor, Eulalia* (*Pollinia*) *fulva, Secale cereale* and *Triticum vulgare*. The number of hosts, including pasture grasses, and especially the native *Bothriochloa intermedia* and *Eulalia fulva*, caused alarm in some quarters,[6] as it was thought that the dissemination of a poisonous fungus with such a wide host range constituted a menace to the pastoral industry. The great epiphytotic of paspalum ergot of 1935-36, and the subsequent persistence of the disease, was cited as an example of what might happen, perhaps with a fungus more dangerous than *C. paspali*.

The problem of the identity of Australian ergots has been investigated by Langdon[17] in Queensland. He found ergot very widely distributed with a wide range of native grass hosts, many of them important pasture grasses, but in no case was it *C. purpurea*. One species, *Claviceps pusilla*, had previously been described from Europe and was found on twelve native species of *Andropogoneae*, including *Bothriochloa intermedia*. There is no doubt that the ergot on this grass recorded as *Claviceps purpurea* is *C. pusilla*. Langdon's evidence suggests that the same ergot occurs also in India and Ceylon. Four new native species of ergot have been described, *Claviceps annulata* on *Eulalia fulva, C. platytricha* on *Ischaemum australe, C. hirtella* on *Eriochloa pseudoacrotricha*, and *C. glabra* on *Digitaria longiflora*. Of these it is of interest to note that *Eulalia fulva* is the other native host previously thought to be attacked by *C. purpurea*. The ergot of rye is held in check by climatic influences, and there seems no likelihood of its becoming more than a minor disease in parts of Australia. Undoubtedly much more work must be done, as Langdon's work was necessarily largely confined to the south-east of Queensland, but the correction of the records of rye ergot on native grasses, and the warning that these species of Claviceps must be considered in any programme of improvement of pastures with native grasses and in the introduction of species indicate one of the important contributions arising from a study of native plant diseases.

Paspalum ergot should be mentioned at this point. The first official record[24] of this disease was that of the epiphytotic of 1935-36 on *P. dilatatum*. This is not a native grass. *P. orbiculare*, a native species, was, however, found affected by ergot and collected in August, 1934, at Beerwah and the specimen is in the Queensland Department of Agriculture collection. Langdon[16] deduces from the records of

Cerebella, a saprophyte on the honey dew of ergot, that *P. orbiculare* ergot can be traced back to 1887 in Queensland. This might suggest a partial explanation of the widespread distribution of Paspalum ergot in the 1935-36 outbreak, which Noble[24] pointed out could have arisen only from a great many focal points. Yet there is some considerable doubt, as the sclerotia germinated by Langdon produced very different stromata from those of other described Paspalum ergots, though this fungus is capable of infecting *P. dilatatum*.

Supposedly Toxic Parasitic Fungi.

Ergot is of special importance because of the danger of poisoning of stock. In that connection, the darnel grass (*Lolium temulentum*) is also worthy of mention. This introduced weed has the reputation of being poisonous, and there is a diversity of opinion as to whether this is due to the presence of an endophytic fungus. McLennan[21] in her thesis published in 1920, pointed out that an apparently identical fungus is present in *Lolium perenne*. Perennial rye grass is not poisonous, and the suggestion has been made that the toxicity of darnel is therefore not due to the fungus. Neill's[23] recent work in New Zealand, however, indicates that the two fungi are distinct, though perhaps only to the extent of being different strains of the same species. This leaves the poisonous nature of the endophyte still in doubt.

Before the discovery of the fungus in darnel grass and the subsequent suspicion of its poisonous nature, a Queensland fungus had acquired a somewhat similar reputation. The finger cherry of North Queensland (*Rhodomyrtus macrocarpa*) has a fruit often eaten without ill effects, but it is supposed to cause blindness and death at times. Cooke and Massee described a fungus, *Gloeosporium periculosum*, from the fruits and since Bailey's publication[2] in 1895 of the suggestion that it was responsible, the belief has become widespread that there is no doubt on the matter. The optic nerve is stated to be destroyed, and numerous reports have been circulated of children being blinded overnight. The writer has been told of a case where a calf tied to a finger cherry bush was found blind next morning. On the other hand, an eye specialist has informed the writer that the cases of reputed finger cherry blindness he has examined show a gradual atrophy of the optic nerve, and were certainly not a sudden affliction. Much of the evidence connected with this plant is hearsay and the literature is mainly a reiteration of Bailey's brief note published in 1895. No cultures of the fungus ever seem to have been made and no laboratory tests carried out. The whole question needs re-examination. It may be mentioned that the host plant contains a saponin, the quantities of which show a seasonal variation.

Economic Aspects.

Toxic or supposedly toxic parasitic fungi are naturally of interest because of their dangerous nature. The vast majority of native plant diseases have little news value, but are none the less important. *Uromycladium tepperianum*, a rust attacking acacias, may destroy commercial plantations of the important tanbark species, *Acacia pycnantha*. The toll taken by rusts and smuts of native grasses remains to be estimated. In wet weather the moulding of Mitchell grasses in the field may be very serious. There is, moreover, the possibility of the transference of attentions by parasites from an unimportant native plant to an important cultivated species. It is a common occurrence for fruit trees planted on the site formerly occupied by certain native trees, especially bloodwoods, to be attacked by *Armillaria mellea*—a fungus which certainly has a cosmopolitan distribution but which is usually not an introduction. Whether the crown gall organism attacking North Queensland maples is native or introduced is uncertain, but it is probably native. It is transferable to certain introduced economic plants, notably citrus.

Native or Introduced ?

It is often difficult and sometimes impossible to decide whether a parasite is introduced or native. With the Irish Blight fungus (*Phytophthora infestans*) there is no doubt, though it does happen to attack *Solanum aviculare*, a native solanaceous plant. Flag smut of wheat (*Urocystis tritici*) was first found in Australia ; it occurs on no other host and is so closely related to *U. occulta* of rye that some authors regard them as biological forms of the same species. There is no doubt that flag smut of wheat is an introduction and the fact that it was first recorded from South Australia merely indicates that it had been introduced and collected there before it was noticed elsewhere. It was later found in India and Japan.[20]

McAlpine[10] described a rust of *Beckmannia erucaeformis*, an American grass raised by him from seed from the United States Department of Agriculture. He found on enquiry that the fungus was present in Minnesota, but had not been named. Examples of this sort of thing could be multiplied. Carne's[5] *Phytophthora hibernalis* described from citrus in Western Australia occurs overseas. Three rusts described from English marigold (*Calendula officinalis*), cineraria (*Senecio cruentis*) and English daisy (*Bellis perennis*) by McAlpine were for a time thought restricted to Australia ; then two of the hosts, cineraria and English daisy, were found affected in New Zealand, and Cunningham[9] found their rusts were conspecific, and identical with a rust, *Puccinia allani*, on a native New Zealand plant, *Senecio lagopus*. These three were consequently placed under *Puccinia distincta*, the first name to be used. The third of the supposedly Australian rusts, " *Puccinia calendulae* ", was examined in Queensland and found to be identical with that on the cineraria and the English daisy and experimental infection finally proved the point beyond dispute.[12] *Puccinia distincta* therefore seems to be a rust of a New Zealand composite, which has gone over to two garden plants in its native land, and been introduced to Australia, where it has extended its range to *Calendula officinalis*. One could imagine the possibility of its passing over to one or other of our native composites in the early years of its introduction, and being regarded as a native Australian rust. As far as is known, however, none of our native plants is attacked, though other introduced composites of the genus *Felicia* have been infected experimentally.

Peronospora tabacina, described by Adam[1] in 1933 as the cause of blue mould on tobacco in Australia, is now considered by Clayton and Stevenson[7] to be native to all temperate regions with a *Nicotiana* flora. The position regarding the powdery mildew of *Lagerstroemia* remains to be cleared up. *Lagerstroemia indica* is commonly attacked in a most striking manner by *Uncinula australiana* in Queensland and New South Wales, but the disease is not recorded from India. It seems very unlikely that the fungus spread from the native *L. archeriana*, which grows in the Palmer River district, and it is more likely that it is an introduction.

Variations within Species.

Where a native plant has an extra-Australian distribution, and its parasites are also found in other countries, it is usual to regard the parasites as native, though it is possible that occasionally the assumption may be unwarranted. We find, however, that with widespread species, or with species with very close relatives elsewhere, there is a marked similarity in the parasites in other countries, with often those slight deviations which one would expect to find after long geographical isolation.

The Queensland rust of *Aristida sciuroides* (a three awned spear grass), for example, does not conform exactly with either *Puccinia aristidae* or *P. aristidicola*, the first from Turkestan and Abyssinia, the second from North and South America and also from India. It is intermediate, but not sufficiently distinct to be named as new species. Nor is a smut (*Ustilago erythraeensis*) from *Hachelochloa granularis*

sufficiently different from an African species on the same host to be regarded as specifically distinct, but rather as a local specialisation with smaller spores.

Australia itself is such a large land mass that similar slight deviations might be expected in widespread fungi, especially where climatic barriers have isolated areas from one another. Unfortunately the native parasitic fungi of Western Australia are too imperfectly known for any generalisation, though the differences in the host plants and the variation in the saprophytic *Basidiomycetes* suggests that the diseases, too, have been affected by isolation.

There is a Western Australian rust, *Aecidium eburneum*, on *Bossiaea linophylla* which differs slightly in spore measurements from that on eastern members of the same genus. Hennings[11] described it as distinct but McAlpine[18] regards it as the same species. Then again there is a rust on one of the *Chenopodiaceae, Threlkeldia drupata*, near Perth. Hennings[10] named this *Puccinia dielsiana*, and it was just sufficiently different for McAlpine[18] to maintain it as distinct from *Puccinia kochiae*, the rust of saltbush in the eastern States. Samuel[26] in 1924 named an allied rust (*Puccinia bassiae*) from various species of *Bassia*. In 1941, Herbert and Langdon[14] examined a rust from *Bassia stelligera* from Yelarbon in Queensland. It was typical *Puccinia kochiae* and certainly not *P. bassiae*. It seems therefore that here we have a saltbush rust in a state of divergent development over a very wide area, and that on *Bassia* in South Australia it has diverged to a point where, like *Puccinia dielsiana* in Western Australia, it might be considered a distinct species. In Queensland, it is still morphologically *Puccinia kochiæ*, though we do not know what physiological specialisation may exist. Of course, further work may show that there are connecting forms which make distinctions very difficult.

On the other hand some of our widespread fungi show remarkable uniformity in spite of distance and climatic conditions. The rust that commonly forms galls on wattles (*Uromycladium tepperianum*) is found in all the States, including Tasmania and Western Australia, and it has been reported on *Albizzia montana* in Java. Then there is the curious case of *Uromycladium alpinum*, first collected in the Victorian Alps, and later found to extend as far north as Rockhampton. There are no significant differences in specimens from different wattles over this wide climatic range.

Geographical Considerations.

Just as our native flowering plants show close relationships with those of Africa, south-eastern Asia, Malaysia, Polynesia and South America, depending in part on past land connections and in part on past and present climates, so the native plant diseases show these affinities. Lists of South American and New Zealand parasitic fungi contain many types found in Australia ; Butler and Bisby[4] in " The Fungi of India " record numerous species common in Australia, especially in the north. In the identification of newly discovered diseases, it is essential to take this plant geographical fact into careful consideration. The Magellanic nature of the beech (*Nothofagus Moorei*) forests in the MacPherson Range suggested that the beech fungus *Cyttaria* might be found there as it is in such forests elsewhere, and resulted in the discovery[13] of *Cyttaria septentrionalis*. With rusts and smuts, which are so numerous and difficult to classify without reference to their hosts, it is of great assistance to have authentic host indices from related botanical regions as an indication of what may be expected in a plant disease survey.

It is of course absolutely essential to go beyond host indices for final identification, but that does not detract from the value of host-parasite lists. Trouble arises particularly with the rusts and smuts when the mycologist pays insufficient attention to the identification of the host, which, after all, is one of the diagnostic characters of the parasite. McAlpine[20] described a smut, *Sorosporium tumefaciens*, on *Stipa*

pubescens from a point near Cloncurry. Mr. S. T. Blake, after an examination of the plate and from a knowledge of the district, pointed out that this was not a *Stipa* at all, but a *Chrysopogon*. A smut obtained on *Chrysopogon pallidus* from the Northern Territory and other material from a *Chrysopogon* (aff. *pallidus*) from Dirranbandi and from Eversham settled the point. *Sorosporium tumefaciens* is a parasite of *Chrysopogon*, not of *Stipa*. Meanwhile, however, Mundkhur[22] in India had found this same smut on *Chrysopogon sericeus*, but with no indication that it had been found and named already, gave it the name of *Sorosporium azmatii*.

This relationship of host-parasite partnerships in different countries may be used as a test of former land connections, and it certainly affords valuable subsidiary evidence, especially in the enquiry into the origin and dispersion of types of present bicentric distribution, such as the beeches, but this is not the place to discuss that matter. Suffice it to say that land connections have undoubtedly played an essential part in the migrations of plants with their diseases, but that the maintenance of that condition depends mainly on the climate. Where in Australia we have Indian climates, we may look for Indian types of disease, but where we have New Zealand climates, we may look for New Zealand types of disease. Unfavourable climates may wipe out this evidence of past land connections, just as they wipe out other biological evidence, and give the critics an opportunity to point out anomalies in distribution.

References.

1. Adam, D. B.: J. Dept. Agric. Vic., 31: 412-416, 1933.
2. Bailey, F. M.: Q. Bot. Bull., 10: 37, 1895.
3. Brown, R.: Appendix to M. Flinders, The Voyage to Terra Australis. London, 1814.
4. Butler, E. J., and Bisby, G. R.: The Fungi of India. Calcutta, 1931.
5. Carne, W. M.: J. and Proc. Roy. Soc. W. Aust., 12: 13-41, 1925.
6. Cheel, E.: Personal communication.
7. Clayton, E. E., and Stevenson, J. A.: Phytopath, 33: 101-113, 1943.
8. Cooke, M. C.: Handbook of Aust. Fungi. London, 1892.
9. Cunningham, G. H.: The Rust Fungi of N.Z. Dunedin, 1931.
10. Hennings, P.: Hedw., 40: 95, 1901.
11. ——————: Hedw., 40: 352, 1901.
12. Herbert, D. A.: J. Aust. Inst. Agric. Sci., 7: 27-28, 1941.
13. ——————: Proc. Roy. Soc. Q., 41: 158-161, 1930.
14. Herbert, D. A., and Langdon, R. F.: Univ. of Q. Papers, 2: 1-6, 1941.
15. Hurst, E.: Poison Plants of N.S.W. Sydney, 1942.
16. Langdon, R. F.: Aust. J. Sci., 3: 169, 1941.
17. ——————: Proc. Roy. Soc. Q., 54: 23-32, 1942.
18. McAlpine, D.: Syst. Arrangement of Aust. Fungi. Melbourne, 1895.
19. ——————: Rusts of Australia. Melbourne, 1906.
20. ——————: Smuts of Australia. Melbourne, 1910.
21. McLennan, E.: Proc. Roy. Soc. Vic., 32: 252-301, 1920.
22. Mundkhur, B. B.: Trans. Brit. Mycol. Soc., 22: 115, 1937.
23. Neill, J. C.: N.Z. J. Sci. and Tech., 23: 185A-193A, 1941.
24. Noble, R. J.: Agric. Gaz. N.S.W., 47: 403-405, 1936.
25. Noble, R. J., Hynes, H. J., McCleery, F. C., and Birmingham, W.A.: Plant Diseases Recorded in N.S.W.. Sci. Bull. 46, Dept. Agric. N.S.W., 1934.
26. Samuel, G.: Proc. Roy. Soc. S. Aust., 48: 152, 1924.

The Significance of Grasshoppers in Soil Conservation in South Australia and Western Australia

By

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In both South Australia and Western Australia a grasshopper problem has developed in areas with similar climates and similar histories of land-use. In both cases the area was originally opened up for wheat ; after producing wheat profitably for a number of seasons the area was abandoned as a wheat-growing proposition and subsequently developed for sheep-raising. In the grasshopper belt in South Australia the change from wheat-growing to sheep-raising has been going on slowly for more than 50 years. In 1937 more than 90% of the total area of holdings in most of the grasshopper belt was used for depasturing sheep.(1)

In Western Australia these developments have been more recent and more rapid. In 1940 there was hardly a sheep in the whole of the marginal areas. By the end of 1943, under a government sponsored scheme, over a million acres will have been withdrawn from wheat production and nearly £500,000 will have been spent in developing the area for pastoral pursuits.

Predominance of Ephemerals in Pastures.

The pastures in these areas are dominated by species of plants which established themselves " naturally " after the land ceased to be used for wheat-growing. Barley grass, speargrass and geranium are common. This type of pasture can produce a luxuriant growth of vegetation during a good season, but this may disappear completely, leaving neither food for sheep nor protective cover for soil during a drought.

In the short view the central problem in land management in this zone is to provide feed for sheep during dry periods, or, alternatively, to avoid economic hardship when it becomes necessary to get rid of sheep owing to shortage of food. It will be apparent from an earlier report(2) which shows the fluctuations in the numbers of sheep in this zone, that this problem has not been solved. The latter will be further borne out by the fact that during the early stages of the 1940 drought in South Australia merino sheep were sold for 1*s*. or 2*s*. 6*d*. per head. At the Wilmington market later whole lots were sold for 1*s*. the lot.

In the long view the central problem in land management in the grasshopper belt is to prevent sheet erosion. In South Australia erosion has already reduced the fertility of large areas and may, in time, change this zone into a desert ; in Western Australia the process has scarcely begun as yet.

In a climatic zone which is subject to drought and where the pastures consist of low annuals, the problems associated with big annual fluctuations in the carrying capacity of the pastures would probably occur in the absence of grasshoppers, but the grasshoppers greatly aggravate the trouble. In a good year there may be so much vegetation that even though the grasshoppers are numerous, there still remains plenty of food for the sheep, but in a dry year their competition with the sheep may greatly increase the shortage of food. Indirectly this tends to increase the rate of soil erosion. If the sheep don't eat the feed, the grasshoppers will ; so the farmer tends to put the sheep on the pasture and get what he can. As a result, there is no reserve of feed to carry the sheep through the summer and the soil is

bereft of protective cover. The sheep pulverise the surface of the soil and the wind blows it away.

The control measures recognised as being effective against grasshoppers, e.g. the use of poison baits, poison sprays, and the ploughing of egg-beds, are uneconomic in an area where 8-10 acres are required to maintain one sheep. Therefore it is useful to consider whether the damage done by grasshoppers may be avoided by the use of less direct control measures, e.g. some modification in farming methods. It is the purpose of this paper to show that, in the grasshopper belt, the establishment of pastures dominated by edible perennial shrubs would not only reduce the damage done by grasshoppers, but would also protect the soil from erosion. (Grasshoppers have been observed to eat a little of such shrubs as *Atriplex* and *Acacia victoriæ*, but for satisfactory development they require grasses, leafy annuals, or certain perennials such as lucerne.)

Value of Perennial Shrubs.

In the climatic zone north of the grasshopper belt in South Australia, where the rainfall is lower and less reliable, the annual fluctuations in the sheep numbers are smaller than in the grasshopper belt. In the former zone the pastures contain a large proportion of edible perennial shrubs and trees, e.g. *Atriplex*, *Kochia* and *Acacia*, which provide a reserve during drought. Not only does this type of pasture make for greater stability in the numbers of sheep that can be carried, but it also provides protection for the soil. In some places, largely due to overstocking, the perennial vegetation has been destroyed and erosion is serious.[4] This problem is already receiving attention, as indicated by Woodroffe,[5] and similar work is being undertaken in connection with pasture regeneration and soil stabilisation in the Murray Mallee (Report of the Waite Agricultural Research Institute, 1939-40, p. 24). There is, however, urgent need for similar work in the grasshopper belts of South Australia and Western Australia.

These conclusions are based on the results of a detailed comparison of the efficiency of the pastures in the grasshopper belt and the pastoral lease country. The details of this comparison will be published elsewhere[2] but the general conclusions may be summarised as follows:

(*a*) There is a significant correlation between the number of sheep per acre and the rainfall. This is higher for the grasshopper belt ($r=0\cdot775$) than in the pastoral lease country ($r=0\cdot448$), indicating a greater dependence on rainfall in the former area. This provides direct evidence that the type of husbandry (which means essentially the type of pasture) used in the grasshopper belt is less efficient at maintaining a stable sheep population than is the type of pasture found in the pastoral lease country. Apparently, the presence in the pastures of edible drought-resistant perennial shrubs prevents the big drop in carrying capacity during a short drought, which is so characteristic of the pastures dominated by low annuals. Similarly, during a good year the competition from the perennials tends to reduce the production of excess temporary feed by the annuals. Thus the presence of edible perennial shrubs tends to "iron out" the annual fluctuations in carrying capacity associated with annual fluctuations in rainfall.

(*b*) There is a lower or negligible correlation between the number of sheep per acre and the price of wool. This means that fluctuations in the price of wool are not important in causing fluctuations in the number of sheep carried on the pastures. In fact no other factors are known which are of the same importance as rainfall. Davidson reached a similar conclusion regarding the fluctuations about the growth curve of the sheep population of South Australia.[3]

(*c*) The annual fluctuations in the number of sheep per acre are greater in the grasshopper belt (coefficient of variation 24·7%) than in the pastoral lease country

(15·2%). But the variability of the rainfall is the reverse, being greater in the pastoral lease country than in the grasshopper belt. If it follows from (*a*) and (*b*) that rainfall is the only important factor influencing the annual fluctuations in the carrying capacities of the pastures, then (*c*) confirms the conclusions set out above, viz. that the pastures of low annuals found in the grasshopper belt are less efficient at maintaining a stable sheep population than are the pastures of the pastoral lease country.

Stability in the number of sheep carried may not be the only criterion for good husbandry. But when it can be shown that the present extreme instability in the carrying capacity of the pasture in the grasshopper belt of South Australia is a major cause both of the farmer's economic difficulties and of soil erosion, then there is little doubt that the maintenance of sheep numbers is very important in good husbandry.

Need for Pasture Regeneration.

There are only three alternatives in the management of these "marginal" lands. (*a*) The present practice of keeping sheep on pastures of low annuals may continue, in which case the evils of wildly fluctuating carrying capacity and the ultimate destruction of the area by erosion would seem inevitable. (*b*) All stock could be removed from the area. In this case no economic return would be received, but presumably the soil would be preserved. It may be necessary to consider this alternative in the light of possible future competition between synthetic fibres and wool. (*c*) Research might be undertaken with the object of establishing pastures dominated by edible perennial shrubs. If (*b*) is rejected, then this is the only course open if these areas are to be preserved for the use of future generations.

Even if competition from wool substitutes should make it uneconomic to produce wool in these areas, it is still necessary to consider other alternatives such as the raising of cattle, or even plant products. The choice lies between a wise modification of farm practice, based on scientific research, and persistence in "exploitation" methods which must ultimately produce a desert.

The last alternative, if successfully undertaken, would involve "changing the face of the countryside". But the change would be no greater than the one which has already taken place since the country was virgin. This first stage was exploitation; the driving force was expressed in the efforts of individuals. The next stage will be reclamation. It is doubtful whether this could be achieved by individual action; it may require planning and organising on a community basis. The urgency may be the greater in South Australia where much erosion has already occurred, but the prize should be greater in Western Australia where the soil is still in its pristine state.

References.

1. Andrewartha, H. G.: J. Dept. Agric. S. Aust., 43: 99, 1939.
2. ————————: J. Dept. Agric. S. Aust., 1943. (In press.)
3. Davidson, J.: Trans. Roy. Soc. S. Aust., 62: 141, 1938.
4. Ratcliffe, F. N.: Coun. Sci. Ind. Res. (Aust.) Pamph. 64, 1936.
5. Woodroffe, K.: J. Aust. Inst. Agric. Sci., 7: 117, 1941.

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The Growth and Fibre Production of Flax*

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Although small areas of flax (*Linum usitatissimum* L.) have been grown in Victoria for many years, the crop did not become one of major importance in Australian agriculture until 1940. The sudden rise in the agricultural status of this crop immediately raised many problems which had to be solved to ensure efficient production. The effect of fertilisers, from both nutritional and commercial aspects, and a knowledge of the qualitative and quantitative development of the fibre in the different portions of the stem were two of the major subjects on which information was lacking. A knowledge of the developmental anatomy of the plant was essential in order to define the best time for harvesting and to interpret the results of experiments measured at one stage in development (as at maturity).

The Effect of Water Supply and Light Intensity.

The growth of the plant and concurrent development of the fibre was studied under four conditions of water supply and light intensity. Half of the plants were placed in normal glasshouse light and half were shaded by a hessian screen. There were two water treatments in each group; half of the plants being grown under normal moisture and half under drought conditions. Eight samplings were made at fortnightly intervals from the time of germination. At the last sampling, plants which had received normal light had reached the yellow-ripe stage. Sections were taken from the base and middle of stems at the first four samplings, and from below the cotyledons and five equidistant positions along the technical length (the distance between the cotyledons and base of flowering stem) at the last four samplings for determining the area of fibre, cross-sectional area and number of fibre cells, number of bundles and degree of lignification of fibre.

Effect on Growth.

The shaded plants were greatly retarded in development and had a lower dry weight, shorter stem length, smaller leaf area, higher water content, a lower yield and percentage of fibre, and smaller and fewer fibre cells than had plants which had received full light. These effects could not be attributed solely to the lower assimilation rates of the droughted plants as there was some secondary deposition of cellulose in fibre cells, which would not be expected if the plants were suffering from carbohydrate starvation. It appeared as if light controlled the growth and development of flax by some effect other than that which it exerts on assimilation; a phenomenon which has also been noted for *Lemna*.[1]

There were no significant differences between the results from normally-watered and droughted plants grown under shade, transpiration being too low for an effective drought to be experienced. The droughted plants were much smaller than normally-watered plants when grown under normal glasshouse light. They had lower dry weights, shorter stem lengths and produced fewer flowers and bolls. Although their growth rates were lower, their net assimilation rates were similar to those of the normally-watered plants. That is, the lower dry weights of the droughted plants were not due to a decrease in the efficiency of the leaves to assimilate carbohydrates but to a reduction in the total leaf area, which was brought about by the rapid

* A summary of some aspects of work carried out by the writer during tenure of the Walter and Eliza Hall Agricultural Research Fellowship at the University of Sydney.

dying-off of the lower leaves. The mean areas of individual leaves were similar in both treatments.

Effect on Fibre Development.

Secondary deposition of cellulose commenced first in the outer cells of the pericycle. As the plant developed, cellulose deposition began in cells progressively towards the inner boundary of the fibre bundle. Very early in development, some cells in all potential fibre bundles showed cellulose deposition. The number of fibre bundles did not change during development, as the cells in which deposition commenced late in development adjoined cells in which there was previous deposition. At the middle of the stem, there was a rapid increase in the number of fibre cells showing cellulose deposition from the time of emergence until flowering. After flowering the rate of increase was much slower although cellulose deposition commenced in new cells right up to full maturity. At the base, however, the number of fibre cells increased slowly up to the time of flowering, after which time there was no further increase. There was a progressive increase in the number of fibre cells per cross-section from the base towards the apex of the stem.

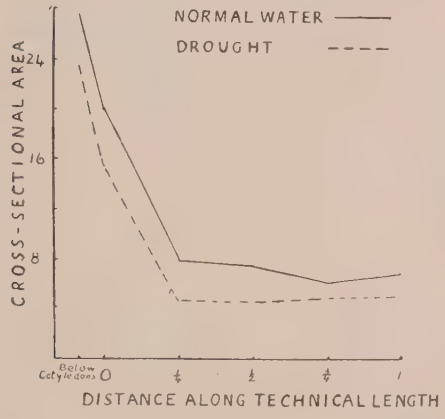

Figure 1.
Cross-sectional area of fibre cells (sq. mm. $\times 10^{-4}$) at different positions in stems from unshaded, normally-watered and droughted plants at the yellow-ripe stage (16 weeks after emergence).

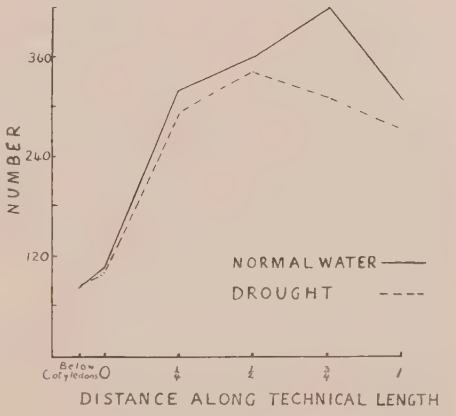

Figure 2.
Number of fibre cells per cross-section at different positions in stems from unshaded, normally-watered and droughted plants at the yellow-ripe stage (16 weeks after emergence).

Drought did not have a marked effect on the number of fibre cells ; only in the upper portions of the stem were there fewer cells in the droughted plants than in the normally-watered plants (Figure 2). Tiver,[3] however, found that fewer cells developed at the middle of stems from droughted plants than from normally-watered plants. Tiver's experiment was conducted over a longer growing season and more fibre cells developed in his plants than in plants from the above experiment. His drought treatment would influence the development of the fibre in all portions of the stem to a greater extent than would the drought treatment in this experiment. At the middle and in the upper portions of the stem, the mean cross-sectional area of fibre cells increased from the time of their initiation until the plants were fully mature. At the base of the plant, the fibre cells increased in size until about flowering ; they then became much smaller owing to shrinkage. The fibre cells at the base were

extremely large compared with cells in the upper stem regions and even at maturity had very large lumens. Shrinkage of these basal cells was almost as great in the normally-watered as in the droughted plants. Drought, however, resulted in smaller cells in the other regions of the stem (Figure 1). It was concluded that the lower yield of fibre from the droughted plants was chiefly a result of smaller fibre cells rather than to fewer cells or shorter stem lengths.

The poor quality of the fibre found in the basal regions of the stem is interesting in view of some controversy as to the relative merits of pulling and of cutting flax. Below and just above the cotyledons, there are comparatively few fibre cells. These cells are very large, have large lumens and mostly occur singly or in pairs. They are also heavily lignified. Fibre from this region would have little commercial value, and would probably be all eliminated as " tow " during scutching.

Results obtained by staining with acid phloroglucin indicated that the fibre from normally-watered plants is more highly lignified than fibre from droughted plants. The results obtained by Tiver[3] also supports these observations.

The Effect of Nutrient Ions and their Interactions.

An exploratory sand culture experiment to determine the effect of interactions between nutrient ions in flax nutrition was designed as a 2^6 factorial experiment, containing all combinations of high and low levels of six ions : nitrogen, phosphorus, potassium, sodium, calcium and magnesium. High levels of each ion were 0·565 gram N, 1·13 grams P, 2·26 grams K, 2·66 grams Na, 2·03 grams Ca, and 2·03 grams Mg. Low levels were one-tenth of these amounts. Each treatment was harvested when it reached the yellow-ripe stage.

Observations were made on dry weight, height (including total height, technical length, and length of flowering stem), number of bolls, water content, yield and percentage of fibre by weight and by volume, cross-sectional area of fibre and of stem, number and size of fibre cells, number of fibre bundles and degree of lignification of fibre. A very brief summary of the results is given herein together with a few illustrations of the importance of ionic interaction in plant nutrition.

Nitrogen and phosphorus were the most important elements, satisfactory yields of straw and fibre being obtained only when these elements were at high levels. The effect of these elements, however, was greatly modified by the concentration and balance of other ions, especially sodium and magnesium, in the culture solution. An increase in the level of potassium had little effect unless both nitrogen and phosphorus were at high levels. High sodium gave greater dry weights and higher fibre yields than did high potassium when combined with high levels of nitrogen and phosphorus. When a high level of sodium was present with high nitrogen and phosphorus, an increase in the level of potassium had no effect on either the dry weight or the fibre content. The ability of sodium to partially replace potassium is probably related to ion uptake. Richards and Shih[3] found that the absorption of phosphorus increased with decreased potassium in solutions high in sodium and the absorption of potassium was greater from solutions high in sodium than low in sodium. In this experiment, the interaction between phosphorus and sodium occurred only at high levels of nitrogen and magnesium. Both ions were kept at high levels by Richards and Shih. An increase in the level of magnesium when present with high levels of nitrogen and phosphorus decreased the fibre content of the plant. There was no effect from increasing the magnesium level if either high nitrogen was present with low phosphorus or low nitrogen with high phosphorus. Richards and Shih[2] found that increased phosphorus increased the succulence, especially if the level of sodium was high. In this experiment, the succulence was greater with increased phosphorus only when magnesium was at a high level. If magnesium was low and calcium high, increased phosphorus decreased the succulence.

Many German investigators have emphasised the effect of an increase in potassium in increasing the number and size of fibre cells. This was found to be true only when nitrogen and phosphorus were at a high level. If the sodium level was high, increased potassium decreased the number of cells per cross-section. An increase in the level of potassium only increased the size of fibre cells when high calcium was present with high nitrogen.

There were wide discrepancies between the results obtained for percentage fibre by weight and percentage fibre by volume. For example, the percentage fibre by volume was significantly lower with high than with low phosphorus, whereas there was no difference in percentage fibre by weight between the two phosphorus levels. It appeared that the density of the fibre was increased by an increase in phosphorus level. High levels of both calcium and magnesium appeared to give fibre of lower density than was obtained with low levels of these ions. In order to clarify this point, further work is being carried out.

An increase in the level of either nitrogen or potassium increased the degree of lignification of the fibre, while an increase in the level of either phosphorus or magnesium decreased it. High magnesium only decreased the lignification, however, as compared with low magnesium when both calcium and sodium were at high levels. When sodium was at a low level and calcium at a high level, the effect of magnesium in reducing the lignification was greatly minimised.

The Effect of Sulphate of Ammonia, Superphosphate, Potash, Seeding Rate and Time of Harvest.

Two field trials, one at Berwick, Vic. and one at Leeton, N.S.W., were conducted in order to obtain information on the effects of and interactions between the three chief fertilisers, seeding rate and time of harvest. The same design was used at both places. It consisted of a single replication of all combinations of three rates of sulphate of ammonia (0, ½ and 1 cwt. per acre), three rates of superphosphate (0, 1 and 2 cwt. per acre), three rates of sulphate of potash (0, ½ and 1 cwt. per acre) and three rates of seeding (50, 70 and 110 lb. Liral Crown seed per acre). The 81 plots were confounded in 9 blocks of 9 plots, and each plot was " split " crossways for the two times of harvest, i.e. at the green-ripe and yellow-ripe stages. Sowing was made with a wheat drill and the plots were harvested by pulling.

Observations were made on yield of total produce, yield of deseeded straw, yield of seed, seed : straw ratios, plant stand, weights of individual plants, yield of seed per plant, height, yield of fibre, and percentage fibre by weight of straw and per plant.

The most profitable yield of total produce from a farmer's point of view was obtained with 1 cwt. superphosphate per acre, sown at the rate of 70 lb. seed per acre and harvested at the green-ripe stage. Sulphate of ammonia or potash either alone or in combination with superphosphate did not give sufficient increase in yield for them to be commercially profitable. The higher yield at the green ripe than at the yellow-ripe stage was partly a result of a greater leaf content in the sheaves of the earlier harvest, but chiefly it was due to the much lower number of plants per plot at the later harvest. There was no difference between the weights of individual plants from both harvests. This decrease in plant stand between the two harvests was most marked in plots receiving sulphate of ammonia and sown at the rate of 110 lb. seed per acre. The only explanation that can be advanced for this decrease is that a large number of plants died between the two harvests as a result of lodging. This is supported by the fact that the greatest loss of plants was in plots with a dense stand of weak-stemmed plants. There were fewer plants in plots receiving superphosphate than in plots with no superphosphate, although this fertiliser did not cause any decrease in plant stand between the two harvests. It was likely that super-

phosphate gave a lower plant stand either by causing a lower germination or by stimulating the growth of earlier-germinating plants which crowded out the later-germinating plants.

Although a farmer would have received a higher return by cutting at the green ripe stage, the miller would have lost in the amount of fibre and seed obtained. The yield of seed and of fibre was much higher at the yellow-ripe than at the green-ripe harvest. The increase in the yield of fibre was due to an increase in the amount of fibre per plant which more than offset the loss resulting from the decrease in plant stand. Superphosphate increased the yield of fibre and of seed as well as the yield of straw. It gave a lower percentage of fibre but by increasing the weight of the plant gave a greater fibre content per plant. Sulphate of ammonia at the rate of ½ cwt. per acre increased the percentage of fibre and weight of plants but because it caused a large decrease in plant stand it did not influence the total fibre yield. Superphosphate appeared to increase the strength and coarseness of the fibre producing a " warp " fibre, while potash appeared to develop a " weft " fibre.

The yield of seed responded more readily to a higher rate of superphosphate than did the yield of straw. This was particularly so at Leeton, where there were no differences in seed yield between plots receiving no superphosphate and plots receiving 1 cwt. superphosphate per acre although the straw yield was much higher. There was a very big increase in the seed yield, however, between plots receiving 1 cwt. and 2 cwt. superphosphate per acre. Differences in the straw yield between the rates were very slight. The results at Berwick were similar, though less marked.

The growth at Leeton was unsatisfactory because of the dry season and insufficient irrigation. Nevertheless, there were very few differences in the comparative results from the two districts. There was a higher seed : straw ratio at Leeton than at Berwick owing to climatic differences. Superphosphate also had a greater effect at Leeton because of the lower phosphate content of the soil.

Conclusions.

Fibre continues to develop in the flax plant right up to the time of full maturity, increasing in quantity and becoming stronger and bolder. That is, it changes from the weft to the warp class. Concurrently, the plant stand decreases. The time of harvest for flax is therefore influenced by the class of fibre required and by the time of maximum yield as determined by fibre content and plant stand. The flax plant requires substantial amounts of phosphorus and nitrogen for maximum yields of straw, fibre and seed. Potash is not important and need only be present in small amounts. Higher yields of straw and fibre are likely to be obtained from soils in which the ratio of sodium and magnesium to calcium is high than from soils in which the ratio is low. Although sulphate of ammonia increases the tendency of plants to lodge, it may be beneficial in some areas as it increases the fibre content of the plant. Under most field conditions, however, best results will probably be obtained by sowing at the rate of 70-80 lb. seed per acre and applying 1 cwt. superphosphate per acre.

References.

1. Ashby, E., and Oxley, T. A. : Ann. Bot., 49 : 309-336, 1935.
2. Richards, F. J., and Shih, S. : Ann. Bot., n.s., 4 : 165-175, 403-425, 1940.
3. Tiver, N. S. : Aust. J. Exp. Biol., 20 : 149-160, 1942.

TECHNICAL NOTES

AN AIR-CONDITIONED EXPERIMENTAL CABINET.

In experimental cabinets previously installed at the Waite Institute, temperature was controlled by the presence in the cabinet of a radiator core for raising the temperature and expansion coils containing sulphur dioxide for lowering it. Whilst relatively accurate temperature control could be obtained, it was very difficult to maintain any steady humidity conditions, due mainly to the drying of air by the cooling pipes. In the cabinet to be briefly described herein the air is not subjected to large temperature variations in localised areas but to small variations over a large surface, following in part the system described by Wilson.[1] This development was essential before humidity control could be exercised with any degree of success.

A general idea of the structure of the cabinet is given by the photo and vertical sectional diagram (Figs. 1 and 2). The sides, bottom and partition wall of the cabinet are made in sections consisting of three-inch cork slabs (P), externally and internally covered by quarter-inch "Masonite" (O) and sealed with bitumen. These are screwed to a framework of 3 in. $\times$ 3 in. timber so joined as to be readily dismantled if desired. The top consists of two panes of $\frac{3}{16}$ inch plate glass (E) each firmly puttied into a wooden frame. These frames are seated on cork gaskets (B) and screwed to the main timbers. Access for cleaning or drying the inner surfaces is therefore easy if and when it is required. Provision has been made for running water to pass over the top pane if necessary.

Figure 1.

External view of cabinet, brine tank, and switch board.

The cabinet is equipped with inner and outer doors giving access to the experimental chamber. The inner consist of wooden frames holding three panes of 26 oz. glass evenly spaced, the outer being half-inch flush panel plywood doors. A door also gives access to the conditioning compartment. All doors close on rubber gaskets to give a good air seal.

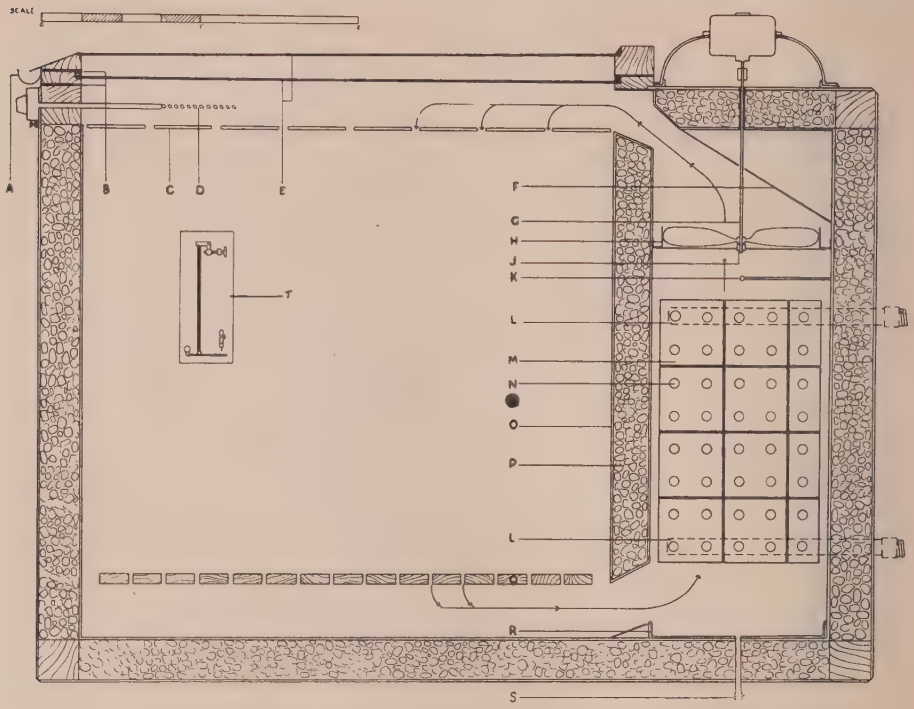

Figure 2.

Diagrammatic vertical section through the cabinet.
A. Waste water guttering. B. Cork gaskets. C. Plate glass spacers. D. Thermostat. E. Plate glass top. F. Brass plate air guide. G. Fan spindle. H. Brass sleeve housing for fan blades. J. Fan spindle bearing. K. Humidifier. L. Inlet and outlet brine pipes. M. Tinned copper flanges. N. Brine pipe. O. Masonite casing. P. Pressed cork sheets. Q. Spacer boards. R. Drip tray. S. Drip tray outlet turncock. T. Hygrostat.
The arrows indicate direction of flow of the air stream.

A number of $\frac{3}{16}$ inch plate glass slabs (C) are fitted on a slide $3\frac{1}{2}$ inches below the lower pane of glass of the top. At the same distance above the bottom a number of stout pieces of timber are similarly placed (Q), forming a false floor. By variation of the space between adjacent pieces of glass or boards circulation of the air is partly controlled.

Air Circulation.

In order to maintain even conditions within the cabinet it is necessary to keep the air constantly moving in such a way as to overcome any dead spots. The movable slabs referred to above make this easy in the chamber itself and at the same time reduce to a minimum the effect of wind velocity within the cabinet. The air is circulated by two 12-inch exhaust fans, each having a displacement of 1,200 cubic feet per minute at high speed but varied by a resistance control down to a minimum of 400 cubic feet per minute. Due to various impediments to air circulation, this displacement in actual use is probably materially reduced. The fan motors are mounted externally, the blades revolving in a horizontal plane on the end of a long hollow spindle (G) mounted in a bearing below the blades (J). The bearing is

lubricated through the hollow spindle. Each set of blades rotates in a short brass cylinder (H) attached to a sheet of brass which completely seals the partition against air movement. Thus all air must be drawn through the conditioning unit and eddy currents are obviated. An inclined sheet copper guide (F) directs the air into the top of the experimental cabinet from which it is drawn between the false floor slabs and through the conditioning unit again.

Temperature Control.

This is obtained by regulation of the temperature of the brine circulated through the conditioning unit. This unit consists of 40 three-quarter inch copper pipes (N) connected in five series to entrance and exit header pipes (L), which reduce the pressure from the circulating pump. The pipes have tinned copper flanges (M) fixed three to the inch, giving a radiating surface of approximately 370 square feet. The fins are staggered to break air currents. The circulating brine is brought to the required temperature in a 20-gallon commercial type insulated brine tank which can be seen situated beneath the bench in Fig. 1. The tank is equipped with 100 feet of $\frac{1}{2}$ inch copper tubing which forms the evaporating coil for a half horsepower twin cylinder compressor for cooling, and two strip heaters (1 Kw. each) for warming. The action of the refrigerating and heating system is controlled by two vacuum switches connected to a thermostat (D) situated in the cabinet. The brine is circulated by a $\frac{3}{4}$ inch centrifugal pump which draws from the bottom of the brine tank and discharges into the upper header on the conditioning unit. In practice it has been found that the cabinet temperatures have been maintained within 0·25° F. of the desired settings (which have ranged from 35° F. to 110° F. during experiments already undertaken) for long periods during which room temperatures have been very variable. The difference between the temperatures of the air in the cabinet and the circulating brine is small. This is important for maintaining constant humidity conditions. To prevent damage to the sealing medium on the insulation in the brine tank, a thermostat breaks the current to the heaters when the temperature of the brine reaches 130° F.

Humidity Control.

At present the cabinet is equipped only to maintain high humidities, but provision has been made for experimenting with and installing apparatus to maintain low humidities when materials become available. In the present set up, the humidifier is switched in when the air dries below a certain point. This is determined by a hygrostat, the outline of which is shown in Fig. 2. A strand of hairs is attached to a short lever which makes contact with a sliding needle. The height of the lever is adjusted by a screw movement. When the hairs dry contact is made and a

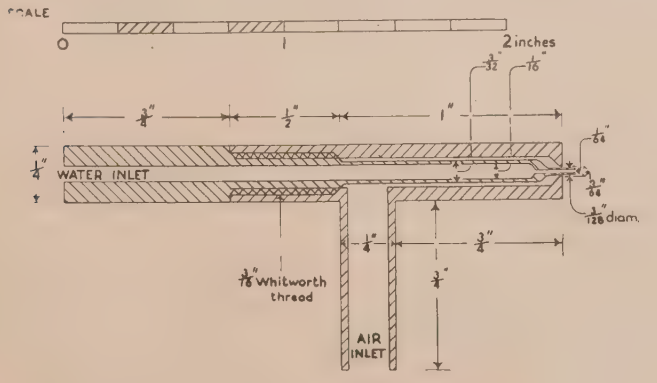

Figure 3.

Sectional diagram of atomiser used in conjunction with the humidifying apparatus

vacuum relay switches in the humidifier. This consists of a small air compressor which is connected via a small air pressure drum to an atomiser, the structure of which is shown in Fig. 3. The central portion with an opening of $\frac{1}{64}$ inch, is connected to a water reservoir at a lower level. The outer casing is connected to the pressure drum. When the pressure reaches approximately 10 lb. per square inch, air passing out through the small hole (diameter $\frac{3}{64}$ inch) produces a suction which brings the water to the opening, where it is discharged as a very fine mist into the air stream just below the fans (see K in Fig. 2). This method has been very efficient in maintaining humidities above 80 per cent. within 2 per cent. of the desired setting, the humidifier operating for only infrequent short periods. Unless the room temperature is considerably below that of the cabinet, condensation is very limited so long as humidities below 95 per cent. saturation are maintained. Above this figure the humidity can be maintained, but some free water runs to waste through the drip tray outlet (S). The actual amount of water used is reasonable, e.g. at 87° F., 92 per cent. saturation was maintained, using 1·6 litres of water in 24 hours.

Relays, etc.

All relays, switches, fuses and resistances are mounted on a switchboard adjacent to but separate from the cabinet (shown in Fig. 1). Relays wired in circuit with the thermostat and hygrostat are of the hotwire vacuum type fitted with surge suppressors where the current is required to start motors. The relay fitted as a safety device in connection with the brine tank is of the magnetic type. The fans and centrifugal pump motors are continually running whilst the cabinet is in use and are manually controlled. Fig. 4 shows the general wiring diagram.

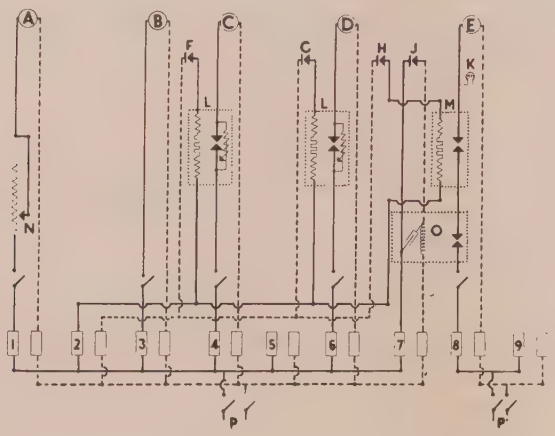

Figure 4.

Wiring diagram of the cabinet.
A. Fan motors.
B. Pump motor.
C. Refrigerator motor.
D. Humidifier motor.
E. Heaters.
F. Thermostat — upper limit contact.
G. Hygrostat.
H. Thermostat — lower limit contact.
J. Brine tank thermostat
K. Heater indicator lamp.
L. Hot wire vacuum switch with surge suppressor.
M. Hot wire vacuum switch.
N. Resistance for fans.
O. Magnetic relay.
P. Main switches.
1-9. Fuses.

Whilst provision has been made for equipping the cabinets with lights, these have not yet been fitted.

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Reference.

1. Wilson, A. R.: Ann. Appl. Biol., 24: 911-931, 1937.

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A MOSAIC VIRUS OF SUBTERRANEAN CLOVER.

For some years, mosaic symptoms associated with pronounced stunting have been observed on plants of *Trifolium subterraneum* in the pasture field at Burnley Gardens, Victoria. In 1941 and 1942, evidence was obtained of the more widespread occurrence of the disease in this State. Its potential importance has recently been emphasised by its rapidity of spread in infected areas, resulting in a reduction of 50 per cent. in spring growth. A study of the virus was begun in 1942, results being summarized below.

Symptoms on Subterranean Clover.

The first sign of infection is a clearing of the main veins of young leaves. This is followed by mottling of the lamina, which becomes progressively more intense. Leaves show distortion to a narrow wedge shape with a wavy leaf margin. Infected plants are dwarfed. Seed production may be considerably reduced and there is some evidence of seed transmission.

Host Range.

Lathyrus odoratus L. Sweet Pea, var. Spencer.
Lupinus angustifolius L. Narrow leaf, New Zealand Blue Lupin.
,, *hirsutus* L.
,, *luteus* L. Yellow Lupin var. German Sweet.
,, *varius* L. W.A. Blue Lupin.
Medicago hispida Gaertn. var *denticulata*. Burr Medick.
,, *lupulina* L. Black Medick.
,, *tribuloides* Desr. Barrel Medick.
,, *arabica* All. Spotted Medick.
Melilotus alba Desr. White Sweet-clover.
,, *indica* All. Yellow Sweet-clover.
Phaseolus vulgaris L. French Bean (23 varieties tested, including No. 5 Refugee).
,, *lunatus* L. var. *macrocarpus*. Henderson's Bush Lima.
Pisum sativum L. var. Mammoth Sugar.
Soya Max Piper, var. Manchu.
Trifolium angustifolium L. Narrow-leaf Clover.
,, *glomeratum* L. Cluster Clover.
,, *hybridum* L. Alsike Clover.
,, *incarnatum* L. Crimson Clover.
,, *minus* L. Suckling Clover.
,, *pratense* L. Red Clover.
,, *striatum* L. Knotted Clover.
Trigonella ornithopodoides D.C. Fenugreek.
,, *Foeno Graecum* L.
Vicia Faba L. vars. major, minor.

Transmission.

Successful transmission has been achieved by expressed juice using the spatula and carborundum method. Dilutions up to, but not beyond, 1 in 1,000 were effective. Transmission of the virus to Crimson Clover and then to French Bean resulted in a higher percentage of infection with increased severity of symptoms than with direct inoculation to French Bean. Aphides were found to transfer the virus.

Thermal Death Point.

The virus is completely inactivated by heating at a temperature of 60° C. for 10 minutes.

Aging.

After 24 hours the percentage of successful transfers was one-third of that recorded immediately on extraction of the juice. After 48 hours, no successful transfers were obtained.

Relationships of the Virus.

Subterranean clover virus differs from other legume viruses described in recent literature in several reactions as given below. Pending a further search for differentiating hosts it is undecided whether the virus is a new record.

(*a*) It infects *Phaseolus vulgaris, Soya Max, Melilotus alba,* while common pea mosaic does not.[2, 4, 6]

(*b*) It infects French bean var. No. 5 Refugee, *Lupinus angustifolius, Melilotus alba, Soya Max, Trifolium hybridum, T. incarnatum, T. pratense, Pisum sativum,* while common bean mosaic does not.[3, 5]

Symptoms on *Phaseolus vulgaris* are also much more severe than for common bean mosaic. The mosaic is more striking, the leaf surface is rugose, the leaflets show early reflexing, and internodes above the first affected leaf are generally stunted. These symptoms characterise such varieties as Brown Beauty, Feltham's Prolific, Canadian Wonder. In the varieties Startler Butter Bean, Burpee's Stringless Longpod, and Bluelake, the reflexing of leaflets is extreme, the leaflets tend to drop off, and the growing point often dies.

(*c*) It infects *Trifolium hybridum, T. pratense, Phaseolus lunatus* (Henderson's Lima Bean), while yellow bean mosaic (white sweet clover mosaic) does not.[7]

(*d*) It infects *Trifolium pratense* and *Soya Max,* while Alsike Clover virus 2 does not.[6]

Suggestions Regarding Control.

Since all the described varieties of subterranean clover in Australia (tested at Burnley Gardens, Victoria)[1] are susceptible, one approach to control appears to be through selection of individual resistant plants from highly infected areas. Another possibility is by the eradication of adjacent perennial legumes which may "oversummer" the virus.

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References.

1. Aitken, Y., and Drake, F. R.: Proc. Roy. Soc. Vic., 53 (N.S., pt. 2): 342, 1941.
2. Chamberlain, E. E.: N.Z. J. Sci. and Tech., 18: 544, 1936.
3. ————————: *Ibid.*, 20: 381, 1938.
4. Murphy, D. M., and Pierce, W. H.: Phytopath., 27: 710, 1937.
5. Pierce, W. H.: Phytopath., 24: 87, 1934.
6. Zaumeyer, W. J.: J. Agric. Res., 60: 433, 1940.
7. ———————— and Wade, B. L.: J. Agric. Res., 53: 161, 1936.

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AN EXAMINATION OF STARTERS USED IN CHEESE FACTORIES.

Starters used in commercial cheese factories consist of single or mixed strains of *Streptococcus lactis* and/or *Streptococcus cremoris*. This investigation was designed with a view to determining the relative proportions of *S. lactis* and *S. cremoris* in mixed strain starters which had been used under ordinary factory conditions for varying periods of time. Nine starters which had been used in the factories for periods varying from a few days to several months were obtained for the study. With the exception of two (C and D), which were said to be " slow " starters, they were all reported to be working normally in the cheese vat.

Isolation and Classification of Starter Components.

It is widely known that a medium may be well suited for the nutrition of one species of lactic acid bacteria but quite unsuited to support good growth of certain other species. In order therefore to secure the development of as many species as possible, each starter was plated out on the following media : milk double digest agar, dextrose agar, beer wort agar and nutrient agar enriched with blood. These media were prepared according to the prescription of Davis.[1] The starters were plated when the acidity had reached 0·6 to 0·8 per cent. calculated as lactic acid. The plates were incubated at 28° C. for five days to permit good development of colonies. Only plates which contained from 20 to 30 well spaced colonies were chosen for the isolation of individual organisms and all colonies on the selected plates were dissected from the medium by means of a sterile platinum needle and inoculated into the appropriate sterile chalk litmus milk medium contained in Macartney bottles. The bottles were incubated at 28° C. and the time taken to coagulate the milk was noted. With slow-growing types which sometimes failed to clot chalk milk, the time for complete reduction of litmus with characteristic red band on the surface of the milk was recorded. The colonies from plates of milk double digest agar and dextrose agar were fished into plain litmus milk, those from beer wort agar into beer wort yeast litmus milk and from blood agar into blood litmus milk. Chalk milk was used in order to preserve the vitality of cultures which were required for future use.

The morphology of the organisms was examined in stained smears from the milk cultures at clotting point. In any cultures where species could not be definitely differentiated by microscopic examination, the biochemical reactions in maltose and dextrin at 40° C. were used to identify the types of lactic acid streptococci isolated. In passing, it should be mentioned that microscopic examination revealed considerable variability in cell size, particularly in the case of strains of *S. cremoris*, which also showed greatly differing numbers of cells per chain in the various clotted milk cultures.

The component bacteria isolated from the starters upon arrival at the laboratory are classified in Table 1 as strains of *S. cremoris* and *S. lactis*, respectively. It will be noted that the proportions of the two common species of lactic streptococci typical of cheese starters varied widely in the starters as received from the factories ; in some starters *S. cremoris* predominated, while in others *S. lactis* was the dominant organism.

Table 2, in which the organisms found in the starters at the first examination are grouped according to the time taken to clot litmus milk, shows that in both the slow-working starters (C and D) there was a definitely lower proportion of organisms capable of rapidly coagulating milk than in the normal starters. Although definite conclusions cannot be drawn from these results because of the limited number of starters examined, the results suggest that rapid acid-producing strains of lactic acid streptococci are sensitive to unfavourable conditions of propagation. Slow starters

TABLE I.

Relative Percentages of S. cremoris *and* S. lactis *found in Starters from Cheese Factories.*

Starter.	Cultures Examined.	Per cent. *S. cremoris.*	Per cent. *S. lactis.*
A	88	11	89
B	73	62	38
C (slow)	42	45	55
D (slow)	41	70	30
E	61	43	57
F	54	59	41
G	42	44	56
H	36	78	22
I	42	19	81

may thus result simply from the attenuation of the starter flora resulting in the replacement of active strains by slow-fermenting strains. The chief factors responsible for the attenuation of strains which occurs under factory conditions of starter control are firstly, the constant subjection to high acidity brought about by over-ripening, and second, the occurrence of temperatures above the optimum of that for the species constituting the starter.

TABLE 2.

Percentage of Cultures Isolated Capable of Coagulating Litmus Milk in various Periods of Time.

Starter.	Cultures Examined.	Time of Coagulation.		
		Within 24 Hours.	24–48 Hours.	Over 48 Hours.
		Per cent.	Per cent.	Per cent.
A	88	67	23	10
B	73	22	44	24
C (slow) ..	42	14	31	55
D (slow) ..	41	—	37	63
E	61	30	40	30
F	54	30	52	18
G	42	12	50	38
H	36	28	33	39
I	42	19	33	48

Arrangements were made for six of the starters to be kept in a dairy for a period of six months in order to observe what changes, if any, took place in the relative proportions of the component bacteria during this time. They were cultured according to the usual factory methods by using pasteurised (not sterilised) milk with fluctuations in incubation temperatures, etc. The results of the microscopic examination of isolated organisms at the expiration of this period are shown in Table 3, from which it is clearly seen that *S. lactis* had overgrown *S. cremoris* in every starter. This is considered to be due to the greater tolerance to acidity of *S. lactis*, a fact already shown by other investigators.[2]

TABLE 3.

Relative Percentages of S. cremoris *and* S. lactis *present in Six Starters after Six Months of Culturing in a Factory.*

Starter.	Cultures Examined.	Per cent. *S. cremoris.*	Per cent. *S. lactis.*
A	36	22	78
B	58	17	83
C	44	18	82
D	40	15	85
E	56	14	86
F	74	22	78

Conclusions.

1. Examination of nine commercial starters, which had been propagated in dairies for varying periods of time, showed that *Streptococcus cremoris* predominated in some starters, *S. lactis* in others. After six months' propagation of six of the starters by methods comparable with factory conditions, it was found that *S. lactis* had overgrown *S. cremoris*, which thus appears to be more sensitive to conditions of factory methods of starter control.

2. Conditions unfavourable for starter propagation in factories may lead to a gradual replacement of active strains of lactic acid streptococci by slow acid-producing strains. This progressive deterioration in the proportion of active strains may ultimately result in a " slow " starter.

3. The practical implication of this investigation is that constant over ripening and subjection to high temperatures should be avoided in the propagation of mother starters at cheese factories ; if this is difficult of attainment, frequent renewal of cultures is advisable.

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References.

1. Davis, J. G. : Proc. Ann. Conf. Soc. Agric. Bact., England, 1936.
2. Yawger, E. S., and Sherman, J. M. : J. Dairy Sci., 20 : 205-212, 1937.

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VARIETAL RESISTANCE OF WHEAT TO LOOSE SMUT.

The most effective way of controlling the diseases of wheat is by the use of resistant varieties. Now that flag smut and stem rust resistant varieties have been made available to Australian farmers, it is natural that wheat breeders should turn their attention to the production of varieties resistant to the lesser diseases such as bunt, loose smut and leaf rust. Although bunt is effectively controlled by dry pickling, there is no doubt that farmers would be very ready to accept a variety that could be safely sown without seed treatment.

Apart from a note of the work being conducted by the New South Wales Department of Agriculture,[5] there is little information available as to the relative resistance of Australian wheats to loose smut. One of the difficulties in breeding resistant varieties has been the lack of some quick and efficient method of inoculation. Moore[3] has used a partial vacuum method and an apparatus similar to that described by him has been successfully used by Vears, of Wagga Experimental Farm, New South Wales. A modification of this apparatus has been made and used in varietal trials at the Waite Institute.

The existence of physiological races of loose smut has long been recognised and although it is not possible to identify the race or races used in this work, the inoculum was originally derived from a single plant in 1940 and has since been maintained on several varieties. Some evidence of its identity is indicated from the fact that Garnet and Khapli reacted in a manner similar to that reported by Hanna[2] for his race R_2.

Experimental.

In 1941 four to six ears of a number of varieties were inoculated, single ears being inoculated at the stage when the first anthers were shedding their pollen. Grain, varying from 20 to 40 seeds from each ear, was used to plant a row in 1942, the rows being replicated four to six times. The results, expressed as a percentage of infected plants per row in each replicate, are given in Table 1. The first four varieties are tetraploids, the remainder hexaploids. Diseased plants of Early Bird were stunted and those of Sword had reddish stems. Leaf lesions were present on the varieties Dan, Sonora and Huguenot. The appearance of three resistant and three susceptible varieties is shown in Figure 1.

Figure 1.

Effect of Loose Smut on harvest from single rows of six varieties. Left to right: Susceptible varieties: King's White, Nabawa, Ghurka. Resistant varieties: Rapier, Dundee and Ford.

TABLE 1.

Infection of Wheat Varieties by Loose Smut (Ustilago tritici).

Variety.	Percentage of Infected Plants per Row Replicate.						Variety.	Percentage of Infected Plants per Row Replicate.					
Khapli ..	0	0	0	0	0	0	S.H.J. ..	31	25	26	45	80	59
Doubbi ..	0	0	0	0	0	0	Fedweb ..	53	29	38	53	44	72
Purple Kernel	3	3	6	13	24	13	Early Bird ..	70	83	55	11*	—	—
Huguenot ..	9	23	25	0	14	5	Geeralying ..	48	63	60	71	63	45
Ford ..	0	0	0	0	0	0	Dan	90	65	44	58	—	—
Dundee ..	0	0	0	0	0	0	Rajah ..	27	80	81	61	71	—
Totadgin ..	0	0	0	0	0	0	Baringa ..	78	52	63	68	63	71
Rapier ..	0	0	0	0	0	0	Currawa ..	88	81	81	79	40	29
Koala ..	0	0	0	0	0	0	Sword ..	0	88	85	86	62	79
Hope ..	0	0	0	0	—	—	Dindiloa ..	87	89	82	93	100	83
Gular ..	0	0	0	0	0	0	Quadrat ..	14	74	85	75	79	85
Gluyas ..	0	0	0	0	0	0	Sonora ..	82	45	100	74	88	—
Bordan ..	0	0	0	0	0	0	Ghurka ..	65	88	63	65	91	78
Pusa 4 ..	0	0	0	0	0	0	Federation ..	75	73	64	76	75	74
Noongar ..	0	0	0	0	—	—	Gluclub ..	69	81	48	80	71	76
Baart 38 ..	0	0	0	0	0	—	King's White	79	41	94	95	84	95
White Federation 38 ..	0	0	0	0	0	0	Indian 6 ..	94	96	88	90	86	88
Riverina ..	0	0	0	0	12	0	Nabawa (*a*) ..	67	68	76	85	49	23
Warigo (*a*) ..	3	0	17	0	—	—	Nabawa (*b*) ..	76	95	77	71	71	100
Warigo (*b*)	0	0	14	0	4	—	Ranee (*a*) ..	67	76	85	100	95	91
Bencubbin ..	22	10	17	11	13	—	Ranee (*b*) ..	79	90	70	86	69	87
Garnet ..	6	9	17	16	41	—	Ranee (*c*) ..	77	55	69	78	69	70

* Inoculated after completion of flowering.
a, *b*, *c*=different accessions of varieties.

Variations in the percentage of infected plants in the replicates of any one variety can usually be attributed to differences in the efficiency of inoculation. For instance, the stigmas of some florets may escape wetting with the spore suspension, and usually there were some differences in the stage of flowering from ear to ear. In addition to these differences it is reasonable to expect that genetic differences may sometimes exist within a variety. If this be the case then it should be possible to select resistant strains from a susceptible variety. Evidence of this genetic variability was found in the variety Sword, where one plant of the six inoculated proved to be resistant. In view of this it is interesting to note that Rapier, a selection from Sword, was resistant.

The results of Table 1 indicate that several of our common Australian varieties are resistant to at least one race of *Ustilago tritici*. Of the vulgare wheats, thirteen varieties were free from smut, four were resistant, and the remainder were quite susceptible.

Six resistant and six susceptible varieties were again inoculated in the spring of 1942 and the results from this test confirmed those previously obtained. An additional variety, Eureka, proved to be susceptible. As there was much loose smut evident in the 1942 plots, seed was harvested with a view to correlating the above results with those obtained from natural infections.

In conclusion it should be emphasised that the above varieties are likely to react differently when inoculated with other races of *U. tritici*. Evidence that additional races exist in South Australia has been obtained by Bowden,[1] who reported the presence of loose smut in crops of Dundee, Ford and Gular. Mundkur[4] refers to Federation as being resistant to loose smut in India.

It is a pleasure to acknowledge the assistance of Mr. S. R. Hockley in this work.

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References.

1. Bowden, O.: Privately communicated.
2. Hanna, W. F.: Canad. J. Res., 15: 141, 1937.
3. Moore, M. B.: Phytopath., 26: 397, 1936.
4. Mundkur, B.: Indian J. Agric. Sci., 11: 675, 1941.
5. Plant Breeding in New South Wales. N.S.W. Dep. Agric. Sci. Bul. 66, 1939.

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The Australian Institute of Agricultural Science

MEETINGS OF COUNCIL.

A meeting of Council was held in the Director's Office, Department of Agriculture, Melbourne, on 22nd February, 1943.

Present.—Mr. H. A. Mullett (V.) (in chair), Dr. H. C. Forster (W.A.), Mr. J. L. Provan (Q.), the Honorary Treasurer, Mr. R. L. Twentyman, and the Honorary Secretary, Mr. A. J. Vasey. Dr. I. F. Phipps attended in place of Dr. A. E. V. Richardson (S.A.). Mr. A. J. Vasey acted on behalf of the A.C.T., Tas., and N.S.W. representatives.

The Institute's submission on Agricultural Economics had been considered by the recent meetings of Standing Committee and Agricultural Council and had been approved in principle for submission to Commonwealth Government.

Confirmation of the appointment of office-bearers made at Council meeting of 11th November, 1942, was received from all delegates. The retiring members of the Qualifications Committee were invited to accept re-appointment.

For the purposes of presenting evidence to the Rural Reconstruction Commission, it was decided that each Branch should prepare material on rural matters concerning its particular State or territory, and that this material be submitted to the Commission by a spokesman of each sub-committee. It was decided to invite Professor Wadham to discuss with Council his ideas as to what particular aspect of rural reconstruction the Institute sub-committees should direct their attention. Professor Wadham indicated that the Commission would welcome the Institute's assistance in its examination of Agricultural Education in the widest sense of the term.

Mr. K. M. Ward was admitted to membership of the Queensland Branch.

The balance at bank was £441 16*s.* 8*d.*

A Council meeting was held in the School of Agriculture, University of Melbourne, on 12th April, 1943.

Present.—Mr. G. W. Leeper (V.) (in chair), Dr. H. C. Forster (W.A.), Mr. J. L. Provan (Q.), Mr. R. W. Prunster (A.C.T.), Mr. G. H. Vasey (N.S.W.), Dr. A. E. V. Richardson (S.A.), Mr. F. S. Crawford (T.), the Honorary Treasurer, Mr. R. L. Twentyman, and the Honorary Secretary, Mr. A. J. Vasey.

After paying the Branch grants at the rate of 5*s.* 6*d.* per member, the financial statement showed a balance at bank of £409 17*s.* 11*d.* In the opinion of Branches, it was considered inadvisable, in the present circumstances, to expend Institute funds on a full meeting of Council.

Following Council's approval, copies of a report on Extension Services in New South Wales have been forwarded to appropriate governmental authorities, together with a covering letter signed by the Presidents of the N.S.W. Branches of the Institute and the Australian Veterinary Association.

The proposal of the New South Wales Branch that Council should recommend to the Commonwealth Government that Agricultural Attachés be attached to Australian Legations abroad was approved. The Honorary Secretary was directed to place this recommendation before the Honourable the Minister for External Affairs, at the same time stressing the need that these attachés should be technically trained men.

The following applicants were admitted to membership :—A.C.T. Branch : P. A. K. Ewart, G. A. H. Helson. Victorian Branch : H. Freeman, R. S. Harper, H. R. Webb.

The report of the Business Manager of the Journal was received, together with a statement of receipts and expenditure, a summary of which is given below. The meeting recorded appreciation of the appearance of the Journal without advertisements.

Report of the Business Manager of the Journal for Volume 8 (1942).

During the past year the war has continued to exert its influence on costs, and fewer overseas enquiries have been received concerning the Journal, except from the United States of America, where continued interest is still maintained.

The only important change during the year was Council's decision, on the recommendation of the Publication Committee, to eliminate advertising from the Journal, commencing with Volume 9, No. 1 (March, 1943). The net value of advertising in Volume 8 was £50 17*s.* 9*d.* As a result of circularising former advertisers, a number of subscriptions were received. Apart from these, the number of subscribers for 1942 was 45, 22 being Australian, 10 British and 13 foreign.

There has been no further reduction in the paper ration available to the Journal during the past year, and up to the present the policy of the Journal has not been affected.

Reprints of 26 papers from Volume 8, amounting to 3,900, were purchased, compared with 24 papers, amounting to 3,220, in the preceding year. Sales of back numbers and volumes showed a slight increase on the preceding period, while despatch of correspondence and single copies of the Journal showed a marked increase.

The statement of accounts showed that the net cost to the Institute of the publication of Volume 8 was £147 7*s.* 2*d.*, which is somewhat less than anticipated and compares with £159 2*s.* 11*d.* in the previous year.

MEETINGS OF BRANCHES.

Australian Capital Territory Branch.

The Eighth Annual General Meeting of the A.C.T. Branch was held on 31st March, and the following office-bearers were elected for the coming year: President and delegate, Dr. J. G. Bald; Honorary Secretary-Treasurer, Mr. K. Loftus Hills; Branch Editor of Journal, Mr. F. Gay; Committee members, Mr. R. Roe, Mr. E. Mackinnon, Dr. C. Barnard, Mr. D. O. Norris.

A general meeting of the Branch on 28th April heard an interesting address by Dr. J. E. Knott, Head of the Division of Truck Crops, University of California. Dr. Knott outlined the work of his department and briefly reviewed the main problems which have arisen in California from the inevitable war-time reorganisation of agriculture.

New South Wales Branch.

Professor J. E. Knott, Head of the Division of Truck Crops of the University of California, who is visiting Australia as a member of the Mission of Economic Warfare, engaged in a survey of the vegetable industry in Australia, was tendered an informal dinner by the New South Wales Branch of the University Union on 5th March. He addressed the meeting on the work of the Truck Crops Division of the University of California.

On 9th April a joint meeting of members of the Institute and the N.S.W. Division of the Australian Veterinary Association was addressed by Mr. W. S. Kelly, Agricultural Adviser to the Prices Commissioner, on " The Revival of British Agriculture—What will be its Effect on our Economy ? " In the between-war period British agriculture presented the paradox of being neglected yet costly. More than half of the farms were under 50 acres, yet measured by turn-over there were many big farms. They had heavily fertilised the arable land, but had neglected the permanent pastures, which was a reason for their dependence on imported foodstuffs, 60 per cent. of human food and 66 per cent. of stock concentrates being imported when the present war broke out.

At the outbreak of war, the British Ministry set the production goals and guided production by means of subsidised price levels. There was a £2 per acre plough-up campaign and bounties for the use of lime and slag. The County War Agricultural Committees had done splendid work for the Ministry in directing manpower and materials so as to secure maximum efficiency. Many research workers of high calibre had been transferred to work with the committees. A high priority had been granted to milk production as the result of the nutrition campaign.

A marked improvement in efficiency had occurred, cultivation had increased 50 per cent., but on the other hand costs of land, plant and stock had risen to levels which indicated inflation dangers. Farm wages had also risen from 18*s.* in 1914 to 34*s.* 7*d.* in 1938, 48*s.* in 1941 and to 60*s.* in 1943.

At present Britain is mining its soils, and in the future will revert to some extent to a system of farming with more animal husbandry. There is no need for Australia to fear lack of markets, if Europe's nutritional needs are to be met as they must be. The diminution of stock numbers in Russia and the need to pour protective foods from Denmark, for example, into the Balkans and other European countries will help solve any conflict between England and Australia in the sane development of their primary and secondary industries.

A general meeting on the 30th April was held expressly to consider the report of the Sub-Committee on Reconstruction. The report recommended the Branch to undertake the study of " Technical Efficiency in Rural Industries, and its Influence on Reconstruction ". The meeting adopted this recommendation together with the following : That this project should be organised by (*a*) appointing individual members (contributors) to make contributions in writing for the field or fields in which they have special knowledge, after consultation with appropriate specialists (consultants) ; (*b*) appointing a small sub-committee with power to co-opt expert contributors, direct research, and to present the project report to the Branch. It was decided that subdivision of subject matter and appointment of contributors be left to the newly appointed Reconstruction Sub-committee, consisting of Mr. W. H. Pawley (Convenor), Dr. F. T. Bowman, Messrs. T. J. Jeffery, W. Poggendorf and H. B. Carter.

Mr. H. P. Brown was elected Branch Editor of the Journal.

Queensland Branch.

At the Eighth Annual General Meeting on March 26th, the following office-bearers were elected for 1943 : President, Mr. W. A. T. Summerville ; Vice-Presidents, Dr. D. A. Herbert and Mr. C. R. von Stieglitz (President-Elect for 1944) ; Hon. Editor, Mr. W. W. Bryan ; Hon. Secretary-Treasurer, Mr. C. W. Winders ; Additional members of Committee, Messrs. A. F. Bell, A. R. Brimblecombe and J. H. Smith.

The presidential address by Dr. D. A. Herbert, on " Diseases of Native Plants in Queensland ", is published elsewhere in this number.

The annual report showed the Branch to be in a satisfactory financial position, cash at bank plus rebate on 1942 collections totalling over £30, while the Branch also possesses War Savings Certificates having a present cash conversion value of £38 5*s*. No Branch dues have been levied since 1941.

An ordinary meeting was held on 7th May to discuss post-war rural reconstruction, with special reference to land settlement, utilisation and conservation and the development of primary assets. This was in response to an invitation for Branch views from the Rural Reconstruction Commission of the Ministry of Post-War Reconstruction. A report is being prepared.

South Australian Branch.

The South Australian Branch held its Annual General Meeting on 26th March. The Secretary's annual report showed that on 31st December, 1942, the Branch had 57 corporate members and 7 student members. Of these, 13 corporate and 7 student members were on active service with the armed forces. The Branch Committee for 1943 consists of D. B. Adam (President), J. K. Taylor (Vice-President), T. T. Colquhoun (Secretary), C. S. Piper (Treasurer), H. G. Andrewartha (Sub-editor), A. R. Callaghan, A. T. Pugsley, T. J. Marshall, and R. I. Herriot.

On 26th March Professor J. E. Knott addressed a general meeting of the Branch on " A Research Program on Californian Truck Crops ". A large number of research and extension projects were discussed during the course of a most instructive lecture.

At a general meeting of the Branch on 9th April members took part in a discussion on " Agricultural Education ", led by Mr. D. B. Adam and Professor H. C. Trumble. Mr. Adam dealt with the training of graduates. He examined the distribution of graduates from the Faculties of Agriculture in the Sydney, Melbourne and Adelaide Universities, and discussed how their training had suited them for their vocations. He put forward some suggestions for improvements in the course. Essentially these suggestions stressed the importance of (*a*) the basic sciences (Physics, Chemistry, Mathematics and Biology), (*b*) the practical year, and (*c*) the need for facilities for a limited degree of specialisation in the final year. Professor H. C. Trumble discussed the organisation of agriculture and suggested some improvements in the present set-up which were desirable in order to keep the farmers more adequately informed about progress in agricultural science. At the conclusion of the discussion the meeting appointed a sub-committee to prepare a report on " Agricultural Education ", which should form the basis for evidence to be submitted to the Rural Reconstruction Commission.

The report was duly prepared and discussed at a general meeting on 7th May. After being modified in certain particulars this report was presented in evidence to the Commission on 17th May. Copies of the report, together with an account of the formal evidence tendered to the Commission, have been circulated to other branches.

Victorian Branch.

The Eighth Annual Meeting of the Victorian Branch was held on 14th May. At the end of last December Branch membership was 124 corporate members; there were four inward and one outward transfers during the year, and sixteen members are on active service. There were fourteen general meetings, eight of which were arranged by the Melbourne University Agricultural Society. Mr. H. A. Mullett, Professor S. M. Wadham and Mr. A. E. V. Richardson formed the Manpower Advisory Sub-committee.

Office-bearers elected for the ensuing year were: President, Mr. J. A. Aird; Vice-Presidents, Mr. R. A. Boyle, Mr. H. A. Mullett (Past President), Professor S. M. Wadham; Secretary, Mr. W. D. Andrew; Treasurer, Mr. C. E. Cole; Sub-Editor, Mr. F. S. Crawford; Members of Committee, Messrs. L. C. Bartels, T. S. Bellair, T. H. Atkinson and J. A. Baker; Auditor, Mr. O. H. Gepp.

Dr. J. S. Hosking gave the address, entitled "Training and Education of Agriculturalists", an account of which appears under Current Notes and News in this issue of the Journal.

On 26th February, Professor J. E. Knott, Professor of Truck Crops in the University of California, and who at present is assisting in the planning of production of vegetable supplies in Australia for the allied forces in this theatre of war, spoke on "Vegetable Investigational Work of the University of California". Professor Knott described the scope of the work and gave details of the problems being investigated in the various sections. These included physiology, plant breeding, pathology and genetics, soils, fertilisers, morphological studies and extension work.

The speaker on 2nd April was Dr. A. R. Callaghan, Principal of Roseworthy Agricultural College, and at present attached to the Department of War Organisation. His subject was "The Work and Activities of the Roseworthy Agricultural College", a summary of which is given under Current Notes and News.

On 30th April members attended the annual meeting of the Melbourne University Agricultural Society to hear Mr. J. L. Provan's presidential address, "Quality—One of Our Objects".

Dr. H. C. Forster was elected President for 1943. Vice-Presidents were Messrs. W. J. B. McDonald and R. T. M. Pescott, and the Secretary Mr. K. H. Northcote.

Quality in horticultural crops depended upon many interrelated factors which were difficult to assess, said Mr. Provan. The recognition and estimation of quality were fundamentally important and were occupying more and more of the research workers' time. Appearance, composition, flavours, colours, vitamins, etc., were gradually being reduced to simple expressions. The search for better sources of Vitamin C had been rewarded in the discovery that the hips of wild species of Rosa contained from 450 to 800 mgms. of ascorbic acid per 100 gms., and Webber, in California, had recently shown that the pericarp of the thin white-fleshed varieties of *Psidium cattleianum* (guava) had an ascorbic acid content ranging from 432 to 653 mgms. per 100 c.cs.

Flowers, trees and shrubs had been improved, chiefly by the enthusiastic amateur or professional nurseryman and seedsmen. The outstanding examples were: Thos. Pockett's chrysanthemums, Errey Bros.' gladioli, and Alister Clarke's roses. Agricultural and horticultural societies, the Burnley trial grounds for dahlias and gladioli and the municipal parks and gardens were all actively interested in the maintenance and improvement of quality in æsthetic plants.

In the edible crops—fruit, vegetables and nuts—various government departments, growers' organisations and leading growers and nurserymen were striving to improve quality. The market return was, of course, the growers' major stimulant to the production of high quality. Keeping quality had been studied and improved by G. B. Tindale and his co-workers.

Citrus fruits might be used as an example of the recognition and estimation of quality in fruits generally. Appearance and composition had been carefully studied and standards for comparison determined. Bud selection had eliminated many poor quality varieties and strains of citrus fruits and the influence of root-stocks had been studied. The replicated citrus root-stock experiment at Leng Bros., Irymple, was commenced in 1931, with the sowing of selected seeds of sweet orange, sour orange and rough lemon (Citronelle) and budded with selected Washington Navel and Valencia Late buds. It was now producing its fifth crop of fruit. The sweet orange root stock produced the best quality fruit.

Western Australian Branch.

On 22nd March, during the visit to W.A. of the Rural Reconstruction Commission, a well attended meeting heard an interesting address from Professor S. M. Wadham on "Rural Sociology". Agricultural progress from rule-of-thumb and traditional practices has occurred in three steps, said the speaker. In succession we have seen at work (1) applied science; (2) applied science plus rural economics; and (3) applied science plus rural economics plus sociological studies. There is evidence that even the combined efforts of (3) may not succeed in improving the farmer's lot, since in many cases a mental lethargy has enveloped him during the past twenty years. Rural propaganda was suggested as the next line of study. Details of a study of social

conditions among wheat farmers in Victoria were outlined by Professor Wadham. In an endeavour to assess their influence on the farmers' outlook, data have been collected on incomes, debts, type of home and its facilities and surroundings, such as gardens, diet, sport and hobbies and literary interests, if any. These data are to be subjected to further study.

The Eighth Annual General Meeting of the W.A. Branch was held on 2nd April, and was devoted mainly to formal business. The following office-bearers were elected for the ensuing year: President, Mr. W. P. Cass Smith; Vice-President, Mr. R. P. Roberts; Hon. Secretary, Mr. G. H. Burvill; Hon. Treasurer, Mr. G. R. W. Meadly; Journal Sub-Editor, Mr. G. H. Burvill; Committee, Messrs. M. Cullity, R. J. Moir and H. R. Powell.

Current Notes and News

Report on Agricultural Extension in New South Wales.

The following report on Agricultural Extension in New South Wales was prepared by a joint committee of the N.S.W. Branches of the Institute and the Australian Veterinary Association.

The committee believes that increased vigour in all extension activities would be a most fruitful investment and it considers that the following proposals would make important contributions to efficiency in the immediate national interest.

Urgent Matters Related to Extension Work arising out of the National Emergency. One of the most urgent needs of the moment is co-ordination between the activities of extension officers acting as Chairmen of Agricultural Committees with executives of Commonwealth Departments (e.g. Man Power, War Organisation of Industry) and State Departments.

The Committee is of the opinion that Experiment Farms of the N.S.W. Department of Agriculture could be used immediately for the training of unskilled farm labour, especially of the Women's Land Army. These farms can provide training in the full range of agricultural and pastoral activities.

Extension Services Proper. It is recommended that the Technical College of the N.S.W. Education Department should conduct a wider range of oral and correspondence courses in special branches of agriculture and a more vigorous and continuous advertisement of all courses among rural committees.

At present the most important methods of extension work by officers of the N.S.W. Department of Agriculture are through personal contact with the farming community and by correspondence. Other methods include field days, meetings and conferences, articles in the *Agricultural Gazette* or in leaflets or bulletins, news items in the press, and broadcast talks. Under the present difficult circumstances, the Committee believes that progress may be made most economically by expanding the more "wholesale" method of extension.

Improved Service in Extension Literature. The Committee considers that a striking weakness of the present system is the comparative lack of the right kind of extension literature. It recommends that present needs can best be met in the following ways:

Within the limits imposed by paper rationing the influence of the *Agricultural Gazette* should be increased by conducting it only as a primary producers' news-sheet of scientific practice, including in every issue, as far as possible, matters of interest to each section of the industry, and by vigorous advertisement.

The more extensive use of popular pamphlets.

The greater use of the metropolitan and country press by the supply of suitable paragraphs and articles issued as frequently as at least once weekly. Such are particularly valuable in developing improvements in special directions.

The provision of a regular information bulletin expressly designed for extension officers. This should comprise abstracts of papers drawn widely from the world's current scientific literature on subjects bearing on Australian problems in addition to progress reports of departmental and other Australian investigations. The importance of such a service as a stimulus to extension officers and providing them with up-to-date information cannot be over-emphasised. This applies particularly to officers permanently stationed in the country.

Greater and More Expert Use of Broadcasting. Generally the radio may be expected to serve best as a means of telling the farmer broadly what information on a particular problem is available and how he may get it. Steps should be taken to ensure that incompetent persons do not broadcast agricultural subjects, and that only up-to-date information should be included.

Extension Campaigns on Special Subjects. The Committee recommends that "drives" on special subjects should be used to an ever increasing degree and should take advantage of all available extension methods.

Refresher Courses for Extension Workers. The Committee recommends that refresher courses should be held more frequently, especially as a preliminary to extension campaigns on selected subjects. Refresher courses suitable for agricultural teachers and teachers who supervise Junior Farmers' Clubs might also be held.

Training and Education of Agriculturalists.

Following is an account of Dr. J. S. Hosking's address of the above title to the Victorian Branch on 14th May.

Within the general scheme of post-war reconstruction, the question of the training of our future agricultural students, whether they propose to follow the pursuits of farming or to become research or extension workers in our various State and Federal departments, needs some considered attention. Few will dispute the fact that there is room for a thorough review of the agricultural training as given at the present moment in the various Australian universities and colleges, since apart altogether from the fact that the agricultural degree courses are very much overloaded in the several States, they appear to be rathed unbalanced. The courses as given were designed essentially to equip students to function as officers within the various Departments of Agriculture and to act as general advisors to the farming community on a wide range of agricultural problems. With this end in view the courses give only a smattering of knowledge on a wide range of subjects related to agriculture without giving a comprehensive knowledge of any one subject. Over the past years, however, the attention of many agricultural graduates has been directed in the channels of research and the numbers of graduates associated with research will no doubt increase in the years to come.

The research fields in which agricultural graduates may be employed are limited through a lack of specialised training, and for many problems those trained in the pure sciences are far better equipped to tackle them. Unfortunately the pure science graduate is seldom sufficiently informed, in his early years at least, on the agricultural aspects of the work to realise the full significance of the problem or to interpret his results in the most satisfactory manner. Co-operative efforts to some extent offset these difficulties, but not entirely.

Another, and from many points of view an even more important, matter is the interpretation of the results of scientific research to the man who is vitally concerned with putting them into practice—the farmer. This is where our agricultural advisory services want overhauling and an efficient training service developed. In our Agricultural Departments today there is a sad lack of advisors who can interpret intelligently to the farmer the vast amount of information which has been collected on specialised branches of agriculture such as soils, animal health, and plant industry, simply because outside the men actively engaged in the investigational work, who have little contact with the man on the land, there are very few who know anything about these subjects.

Hence any survey of the training of agriculturalists embraces three primary aspects. The first concerns itself with the agricultural degree or college course and whether its purpose is to enable a man to farm efficiently or to train for research or extension work. The second deals with the agricultural training essential for pure science graduates to fit them for efficient service in the fields of agriculture. Should this be of a graduate or post-graduate type ? The third concerns the whole field of the training of advisors and the liaison between research organisations, the advisors and the farmer. Closer contact between the first and last named appears necessary in many instances.

The question now arises, what steps shall be taken to give the optimum training to fit graduates to take their rightful place in the whole agricultural set-up ? It is here the Institute has an important rôle to play in surveying the whole question. Furthermore, where does the training start ? Where does specialisation begin ? What steps can be taken to enable the average agriculturalist to express himself efficiently ? What cultural training concerned with the social sciencies and humanities is necessary to give the agricultural as well as the pure scientist a better knowledge and understanding of the world around him and to give him a wider outlook generally ?

Some Problems in Agricultural Education.

1. Pre-university training. The question of pre-university training is as important or more so in many respects than the university course itself. Attention will have to be given to aspects of the secondary school curricula.

2. Cultural training. Should courses in social sciences, elements of sociology and citizenship, psychology, moral and political philosophy, as well as economics, be included in the university curriculum or should certain of these subjects be required, as in America, as prerequisites to entrance to the universities.

3. English, self expression and the writing of reports. Many scientific workers have not the ability to express themselves clearly either in words or on paper. Should courses in English with special emphasis on the writing of reports and journal articles be included in courses ?

4. Financial assistance to students. Now that the government has instituted the principle of assistance to students we should bear this aspect in mind in any deliberations concerning the possible length of university courses.

5. Training in specific fields. Discussions with agricultural graduates, teachers, and departmental and research workers have shown a conviction that there is necessity for action.

Multiplication of the agricultural course into those with a plant, animal soil or entomological bias or into those with a chemical or biological bias seems a reasonable solution as far as the degree course itself is concerned. By this it is not meant that specialisation should be practised from the start, but that by following a general course for the first two years in a four-year course, and the judicious selection of the individual subjects or groups of subjects subsequent thereto in the third and fourth years, a man may be better equipped to function as an agronomist, animal scientist, bacteriologist, soil scientist, etc., than he may at present with an overloading of unnecessary study, use for which may not always be found. There should be a general blending of practical and theoretical training.

In American universities multiplication is practised, and the University of California may be taken as an example. The curricula include plant science, animal science, soil science, entomology and parasitology and seven other subjects. Within these, no less than eleven major lines of study, such as agrostology, genetics, horticulture, plant pathology, fruit products, etc., may be pursued in the field of plant science and five major lines of study, such as animal husbandry, poultry husbandry and dairy industry, in the field of animal science.

6. Present and possible future demands for agricultural graduates. The extent of any alteration in the present Australian university curricula must depend on the demand for graduates in the future. With a markedly increased demand, more students will be encouraged to take up agriculture as a profession, and the necessity for multiplication will increase. Whereas in America and other universities the large number on the teaching staff ensures the specialised teaching in so many branches of agriculture, the small staffs in Australian universities may not allow this to be carried out satisfactorily. The close proximity of scientific institutions such as C.S.I.R. and the possibility of the co-operation of specialists on their staffs, who may be able to give some instruction in the universities, may offset this difficulty. Another solution may be the setting up of specialised schools in different universities and the encouragement of students, who wish to follow these specific fields, to do their training at the appropriate university. Government assistance should be helpful in this direction.

7. Coordination of university and agricultural studies. While at present the agricultural colleges are linked with the universities to some extent, in that certain of them offer facilities for the practical training of university students, there is room for more co-ordination of the work of both types of institutions.

8. Advisory services. The agricultural advisor is just as important as the research worker in the agricultural field and in many respects has a more important and more difficult rôle to play. There appear to be two classes of advisors, the district advisors who have to act as general consultants on all problems likely to arise in general farming practices and the specialist advisor who has to advise on many specific problems. In certain respects they bear the same relationship to each other as the general practitioner bears to the specialist in medicine. The question is, can we produce an efficient advisory service by academic training alone or must our advisors be those with a wealth of scientific achievement behind them ?

Roseworthy Agricultural College.

The work and interests of Roseworthy Agricultural College were discussed by Dr. A. R. Callaghan at a meeting of the Victorian Branch on 2nd April.

In normal times the College accommodates approximately 80 students, and adequate provision of all that is needful for their comfort and well-being is provided. The main course is in agriculture, in which a diploma is given which embraces a sound training in the five basic professional subjects of agriculture, animal husbandry, dairying, fruit culture and viticulture. In 1936 a special course in œnology or wine making was established. The diploma in œnology is an advanced status and men trained in this course are widely sought after from the wine trade all over Australia.

The College farm covers 2,343 acres. Of this about 100 acres are occupied by vineyard, orchard and vegetable production. The farm proper is utilised for experimental work and general farming operations. The axiom on which the College farm is run is to lead the farming community in advanced methods and farm procedure and not be led by the farmer. Suitable rotation of crops is carried out and operations are conducted as near the theoretical ideal as practice will permit. In other words students have the advantage of putting into practice as much as possible what is taught in the classroom, thereby gaining a truer practical perspective in the work they are being taught.

In normal times the field experimental work covered some 200 acres. Experiments deal with manures and fertilisers, method of soil preparation and rotations, and embrace plant breeding work with wheat, oats, barley and field peas. In addition investigational work on animal husbandry, cereal chemistry, fruit processing, wine making, cheese production and fodder conservation is undertaken. The provision of pure seed of all the important cereal varieties is another of the important services rendered to the rural community by the College.

In recent years particular emphasis has been placed on the diversification of production on the College farm. This has involved increased activity with livestock, accompanied by an equally active increase and interest in fodder conservation. As a result wheat growing, as such, no longer takes the pre-eminent place it did in former years on the College farm.

An average of 1,500 head of sheep is carried throughout the year. This consists of a Southdown stud of 100 ewes, a small Merino stud, while the remainder of the flock consists of half-bred ewes for fat lamb production and experimental work, and Merino ewes for the maintenance of the half-bred flocks. The main half-bred flock is of Border Leicester-Merinos. In addition for experimental purposes Dorset Horn-Merino and Romney Marsh-Merino half-bred flocks are carried. The latter flock is now being dispersed, and full reliance in future will be placed primarily on the Border Leicester-Merino flock which has given outstanding results at the College. All aspects of sheep husbandry are dealt with in practice as well as in the classroom, shearing and wool classing being essentials in the work.

A Jersey stud herd of from 35 to 40 milking cows is maintained throughout the year. Associated with the dairying section is a first-class factory only completed in 1940. This is fitted with modern pasteurising and churning equipment and a small cheese experimental section. A beef cattle enterprise of some 60 Shorthorn cattle has recently been established. Studs of Berkshire and Tamworth pigs are maintained and normally the swine herd consists of some 200 pigs. In addition the farm carries about 100 head of horses, including foals and young unbroken animals. A Clydesdale stud of particularly high standard has been built up in the last ten years. Approximately 1,200 head of poultry, chiefly fowls, but including ducks and turkeys, are the basis of practical instruction in this subject.

Book Review

SOIL AND PLANT ANALYSIS, by C. S. Piper, D.Sc.

A Monograph from the Waite Agricultural Research Institute.

(*Pp. x*+368, *with* 19 *illustrations. The University of Adelaide.* 1942. *Price* 15s.)

This book, described by the author as a " laboratory manual of methods for the examination of soil and the determination of the inorganic constituents of plants ", is a collection of methods used at the Waite Agricultural Research Institute. The methods are clearly described with a wealth of practical detail. All likely sources of error and necessary precautions are indicated, a sure and certain sign that the methods have been tested by a careful and observant worker. In this respect this book is especially valuable, as each method can be relied upon to give results of the degree of accuracy indicated, provided the investigator observes the conditions laid down by the author. The book is divided into two parts. Part one, which is devoted to methods for the physical and chemical examination of soils, is a virile offspring of a pamphlet entitled " Methods for the Examination of Soils ", published by the Council for Scientific and Industrial Research in 1928. It contains much material not included in the earlier publication, such as estimation of exchangeable hydrogen, direct estimation of sodium, an account of the glass electrode and helpful general discussions which precede many of the analytical procedures. Part two, which deals with methods for the determination of the inorganic constituents of plants, is entirely new and constitutes a most valuable addition to the book. At the present time, plant analysis, especially in its relation to soil deficiency problems, is a subject of wide interest, consequently this section will be welcomed by all workers in this field of research, especially as a considerable amount of useful information on boron, cobalt, copper, iron, manganese, molybdenum and zinc has been collected here in a readily accessible form for the first time.

The book is attractively printed and for a work of this type is singularly free from typographical errors, the only one noted being on page 203, where ' silver nitrate ' is misprinted for ' silver sulphate '.

The high reputation of the author and of the institute to which he is attached should ensure this publication becoming a standard work of reference for agricultural workers, and with periodic revisions should remain so for many years to come.

E. Griffiths.

Obituary

PETER R. GORRIE.

We regret to announce that Lieutenant Peter R. Gorrie, a member of the Institute, was killed in action at Buna, in New Guinea, at the end of last year.

Peter Gorrie was educated at Scotch College, Perth, W.A., and later at the University of Western Australia, where he graduated B.Sc. (Agric.) in March, 1940. He was one of the few Western Australian agricultural graduates who had decided to go into the teaching profession and, before joining the A.I.F., had been accepted by the Education Department. He joined the A.I.F. in 1940 and went abroad with them to the Middle East, where he saw service as a signaller sergeant. He was commissioned on his return to Australia and was attached to a battalion as lieutenant when killed in action.

Peter Gorrie was a great favourite with his colleagues in his student days and his great interest in and sympathy with boys, coupled with his acute sense of humour, would have made him a fine master.

Personal Notes

F. C. Henderson, R.A.A.F., formerly Agricultural Instructor in the Mandated Territory of New Guinea, has been promoted to the rank of Flying-Officer (Meteorological Service) at an operational station.

Professor J. A. Prescott visited N.S.W. in March. Among the country districts he visited was the New England, where, in addition to the expansion of new crops, he was particularly impressed by the work of local group of women land workers known as the Women's Agricultural Security Production Service.

Mr. H. P. Brown has been appointed Organising Secretary for the Agricultural Bureau of N.S.W., as well as being Secretary to the N.S.W. Council of Primary Producers' Associations.

Mr. J. Wright, resident Entomologist at Grafton, N.S.W., for a number of years, has been seconded to the Division of Plant Industry in the N.S.W. Department of Agriculture for extension work with sweet corn in the Windsor district.

Lieutenant D. O. Atherton, of the Queensland Branch, has been promoted to Captain.

Mr. K. Woodroffe has been released from the R.A.A.F. for work in the Department of War Organisation of Industry. Mr. R. L. Crocker has been released by the Ministry of Munitions for work at the Waite Institute. He will assist the Agronomy Department with their work on Guayule.

Mr. F. H. Hooper has been transferred from the Ministry of Munitions to the Department of Supply and Development. He is working with the Controller of Defence Foodstuffs.

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